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ART. XXXVI.—*On some of the Mining Districts of Arizona near the Rio Colorado, with remarks on the Climate, &c.;* by B. SILLIMAN.[1]

Itinerary and characteristics of the Mojave Desert.—In July, 1864, I visited the Colorado river for the purpose of seeing some of the mineral districts near Fort Mojave. The route followed was from Los Angeles in California by the Cajon Pass and Mojave Desert to Fort Mojave. After leaving the vineyard of Cocamunga the journey is made by encampments. The distance from Los Angeles to the Colorado is about 250 miles, which we made in nine encampments. Few of the stations on this route are laid down on any of the published maps, and are generally watering places only, the whole distance being an uninhabited wilderness, nearly destitute of the means of supporting life. The Mojave desert is entered at the summit of the Cajon Pass, where the road passes through a dug way in masses of sandstone, upturned beds of, probably, Tertiary age. The highest point of this pass is (by barometer) about 4000 feet above tide, and is distant about 25 miles from Cocamunga vineyard. The Mojave river is passed at the 'upper crossings,' about 20 miles from the 'Toll Gate' of the Cajon Pass, and at an elevation of about 2650 feet. The Mojave river, as is probably pretty well known to most readers, is a river in name only, existing, so far as it has water at all, as a series of lagoons with long intervals where not a trace of water can be found. At the so-called

[1] Read before the National Academy of Sciences at Washington, D. C., January, 1866.

'Upper Crossings' it is seen a few inches deep, flowing with a gentle current eastwardly over a pebbly bottom, but disappearing in a short distance, and never appearing again as a running stream. At the Fish Ponds, Camp Cady, and the Caves, the water re-appears but only in stagnant or torpid pools. The line of the river is however perfectly well marked by rounded boulders and smooth river shingle, and along its dry banks grow some shrubs of which the the so-called willow (a bignoniaceous plant with narrow willow-like leaves) is the most conspicuous, and more rarely the Mezquit bean of the Mojave Indians (*Cercidium Floridium*).

The rough road, often very difficult for an ambulance, follows the dry bed of this so-called river, the grade being pretty steadily downward from the 'Pass' to Soda Springs, 150 miles or thereabouts from the Toll Gate.[3] At Soda Springs the barometer stood at 29·355 inches, being the lowest point in the desert of the Mojave, and differing, by the mean of my observations, only 0·195 in. from the level of the Rio Colorado at Fort Mojave.

Soda Springs marks the site of an ancient lake, the surface of the saline plane being as level as the sea. A powerful spring of calcareous water breaks out on its western margin, charged with sulphate of lime, and bearing, among the ignorant guides of these desert regions, the reputation of containing arsenic or some other deadly metallic poison. We drank freely of it, however, with no ill effects to man or beast, and were very glad to obtain so potable a water after several days of great dearth of this essential of comfort.

The term 'Soda Spring' is a misnomer, as the water is destitute both of carbonic acid and alkalinity (it did not affect reddened litmus); has doubtless received its name from its bright sparkling appearance, so much in contrast with the green stagnant water of the 'government holes,' or wells, dug by the roadside for the supply of travellers.

A gigantic fly abounds at Soda Springs and Marl Springs. They were such an annoyance to our animals as to compel us in each case to move on before we were ready, to avoid the torments they inflicted on the poor beasts with their sharp lancets, drawing blood every time when, with a droning sound like that of a humble bee, they struck the skin. They seem to attack the animals in preference to men, as none of our party suffered from them.

From Soda Springs—"the sink of the Mojave"—the road, going toward the Colorado, rises in 25 miles to "Marl Springs"

[3] An adventurous pioneer on the outskirts of civilization has erected a toll gate just before entering the Cajon Pass, where he exacts a fee of all passers in return for some labor bestowed upon the road at that point; this 'black mail' is cheerfully paid to the self-constituted supervisor.

nearly 3000 feet, and thence in 18 miles farther, at 'Rock Springs,' it reaches an elevation of nearly 3800 feet above Soda Springs. From this point it rapidly descends again in 23 miles to Pah Utah creek, about 1800 feet, and from that point the grade is rapidly descending to the Rio Colorado at Fort Mojave, falling in 24 miles a little over 2000 feet.

Climate at Fort Mojave and vicinity.—Dr. John Stark, Post-surgeon at the military station, Fort Mojave, has kindly furnished me with a copy of his record of temperatures kept at the fort for one year, from Nov., 1863, to Oct., 1864. The following table of monthly averages, prepared by me from Dr. Stark's observations, for the three daily periods of observation, is of interest in this connection.

Table showing the mean monthly temperatures for one year, and also the maxima and minima at Fort Mojave, Arizona, very near Lat. 35°.

	MEANS.			MAXIMA.			MINIMA.		
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.
1863.	°	°	°	°	°	°	°	°	°
November,	48·96	72·50	58·76	63	85	76	38	54	46
December,	42·02	65	53·96	57	77	62	36	58	49
1864.									
January,	40·97	68·58	58·38	62	80	70	31	56	43
February,	52·31	78·48	63·06	69	90	77	28	56	43
March,	52·12	80·00	64·35	58	90	75	41	70	57
April,	69·83	90·11	80·01	83	102	87	52	73	60
May,	73·64	89·29	78·64	85	102	92	62	70	60
June,	77·40	99·10	87·10	88	106	98	63	88	72
July,	84·23	106·09	96·38	94	111	102	73	101	91
August,	87·35	106·67	97·48	95	115	104	79	99	87
September,	76·30	100·80	88·03	88	108	97	65	90	72
October,	62·09	86·22	72·29	74	100	83	45	70	59

From this table December is seen to be the month of lowest mean temperature, although the minimum degrees of heat are seen in January and February.

The greatest heats are found in July and August, when the temperature is seen to be most remarkably uniform, the maximum being in fact almost identical for the three daily periods of observation respectively throughout, while at 2 P. M. the minimum temperature reaches the remarkable extreme of 101° in July, and 99° in August.[3]

In the San Francisco District, Arizona, the maximum temperature observed by me in August was 101°.

[3] "No rain of any consequence," says Dr. Stark, "falls at this post except during the months of July and August, though heavy rains are of very frequent occurrence in the surrounding hills. The rain guage has not been regularly kept at this post, but I estimate the mean amount of rain for the years of observation to be about four inches.

"At Fort Yuma, near the mouth of the Rio Colorado, accurate observations show only three inches of rain for the year. Snow has not fallen in this valley since I have been here, now two years.

"The atmosphere, of course, is very dry, dew never being seen. In view of this

The barometer (aneroid) at Fort Mojave was noted in my journal as 29·55 to 29·75. At Allen's Camp, San Francisco District, it was 28·193, average of twelve observations between July 26th and Aug. 1st, the greatest difference being ·055.

The highest temperature noted in the sun was 120° F., at San Juan Camp, (bar. 27·65), Aug. 6. In the sand the mercury rose to 136°, and eggs are coagulated by burying in the sands in 20 or 30 minutes exposure.

The wet-bulb thermometer, which was observed thrice daily during our journey out and back, indicated all through the Mojave Desert and the Colorado regions a remarkable dryness of the air. A few examples will serve as illustrations.

July 21, Mojave Desert, 2 P. M.,	air 104°,	wet-bulb 66,	dif. 38°
" 22, " "	" 104	" 70	" 34
" 26, Fort Mojave, "	" 108	" 75	" 33
" 28, Allen's Camp,	" 101·5	" 70	" 31½
Aug. 1, 10 miles south of Fort Mojave,	" 109	" 73	" 36

Even at night this difference was very remarkable, sometimes as much as 20°, thus:

Aug. 13, Forks of Mormon Road, 9½ P. M.,	air 82°,	wet-bulb 60°,	dif. 22°
" 14, Cottonwood, 9 P. M.,	" 76	" 59	" 17

The 2 P. M. observation rarely gave less than 20° difference between the wet- and dry-bulb thermometers.

Hot wind storms, or sirrocos, are not unfrequent in the desert and on the Colorado. I find this mention of one of these sand storms on the desert in my notes of the journey. "Soon after we had spread our blankets at a 'dry camp' on the plain, about 9 P. M. we heard a roaring sound coming up from the south like the sound of breakers on the shore. As the noise came nearer the resemblance to the roar of the ocean increased, and presently the blast struck us hot as the wind from a furnace, bearing along with it a blinding and almost stifling hurtle of sand, pelting the skin like hail. In vain did we seek to shut it out by covering the head with our blankets. It sifted through all our defenses, filled the hair, was inhaled by nose and mouth and gritted in the teeth, making the skin feel like sand-paper, while the oppressive heat was made ten-fold worse by our efforts to exclude the sand by burying our heads under blankets. It seemed for a time as if we should be buried alive under the

fact I hazard nothing in saying that a more healthful and healing climate for those laboring under that great destroyer, phthisis, could not be desired. These cases seldom present themselves, and then only among emigrants. With simple remedies nature immediately restores good health. I should be glad if this fact were more generally known to those suffering from this disease in eastern cities. * *

"I am now stationed here about two years and have not had a death among the troops during that period; evidence that good health is our epidemic."

drifting sands, but in about an hour the violence of the storm abated, vivid lightening and powerful thunder to the east of us succeeded, and, an hour later, a dash of rain for a few moments, just the outer skirt of the thunder storm, but enough to drive me to seek the shelter of the ambulance.

At Fort Mojave we experienced another similar wind-storm with the temperature over 100°, occasioning more annoyance from the scorching effects of the powerful hot wind.

The officers at Fort Mojave assured us that these hot wind-storms blow sometimes with great violence for a whole week, when it is impossible to go abroad; men and animals being liable to be lost if overtaken on the open desert, as it is then no longer possible to observe the way, gain a shelter, or find water, the latter difficult enough under the best circumstances."

Any notice here of the geology of the Mojave Desert, would extend this paper beyond its proper limits.

San Francisco District.

Situation and approach.—The San Francisco Mining District is located upon the eastern side of the Colorado river, Allen's Camp, about the center of the district, being stated as 11½ miles from Fort Mojave. Allen's Camp is situated upon Silver Creek so called, a dry arroya which divides the San Francisco District into two nearly equal parts. Measured upon the course of the river, this District extends about twenty miles, or ten on each side of Silver Creek, from north to south. In the other direction, from east to west, the District extends about ten miles, the eastern limit being the first range of mountains, of which the most conspicuous point is known as Boundary Peak.

General Features and outcroppings of the Mineral Veins.—The observer is struck, upon entering this District, with the singularly wild and fantastic outline of its bounding mountains and intermediate ridges; he learns with surprise that the bold and serrated peaks stretching from east to west, and rising, now in delicate needles, and again prolonged in acute ridges, are the outcrops of gigantic quartz lodes, among which are seen conspicuously the Moss lode on the north,—the Skinner and Parsons on the south. The general aspect of these outcrops is different from that of those seen in any other portion of the Great American Desert that I have had the opportunity of examining. Whether from the influence of volcanic heat or of atmospheric causes, or,—which is more probable—of both combined, the aspect of these great quartz ridges is more rugged than any others which we have observed. The general course of the lodes in this District is that of pretty strict parallelism to the east and west magnetic equator, the deviations from this course seldom exceeding 4° or 5° by the compass.

This is true of by far the greater number of all the outcroppings in the District. There is another set of lodes, however, much less numerous than the first, whose general direction is northwest and southeast, or more exactly N. 20° W.: these lodes, if prolonged, must obviously intersect, at certain points, some of the east-and-west lodes. They differ not only in their course and direction, but essentially in their mineralogical constitution. The first series, the east-and-west, are quartz lodes, characterized by the presence of feldspar and fluor spar as the peculiar associate minerals; showing also rather rarely at surface metallic sulphurets and free gold. The second set of lodes may be called calcareous, being composed to a great extent of magnesian carbonate of lime or dolomite, flanked in some cases by quartz linings with polished walls, and as a general rule quite barren and unpromising in their outcrop. The Virginia, Olive Oatman, and Buffalo are conspicuous examples of the calcareous lodes. A third class of lodes is observed in the San Francisco District whose main direction is northeast and southwest. This class is very small, not including more than three or four, namely, the Pride of Mexico, Triumvirate, Wright, and Morning Star.

Resources in timber and water.—San Francisco District, like all the neighboring regions of the Colorado, is entirely destitute of timber, and at present is very imperfectly supplied with water. Timber is said, however, to exist in considerable abundance,—cotton-wood, cedar, pitch-pine, and nut-pine,—on or near the banks of the Colorado, within 100 miles of Silver Creek; at points from which it can be brought at a moderate cost for the supply of fuel and mining timber to meet the future demands of this district.

When we remember the experience in Nevada, especially the dearth of water on Mt. Davidson, in the early history of mining on the Comstock lode in Virginia City, and its present comparative abundance there as the result of mining operations, we are encouraged to believe that a similar result may be expected in San Francisco District, especially since the very limited explorations which have been carried out here have resulted in the discovery of water even in the driest situations.

This region is liable, like all the adjacent semi-desert districts, to sudden and violent storms of rain and wind, which may, as we had occasion to observe during our residence at Silver Creek, in a single hour, convert the dry arroya into a broad and roaring torrent, sweeping everything before it; while a few hours after scarce a trace of the inundation remains beyond the sand bars and pools of slime which a few days sun reduces again to the condition of dust. Wells sunk along the line of these dry water courses find an abundant supply of water at a few feet

from the surface, which although hard, becomes reasonably good if constantly used.

Saline or alkali incrustations.—Like all other regions of the Great American Desert the surface of this District is abundantly charged with saline substances familiarly known as "alkali;" salts derived from the decomposition of the alkali minerals of the porphyritic and volcanic rocks which characterize the region. It is the solution of these substances in the drainage waters which gives most of the springs in this section those deleterious properties known as alkalinity. It is to be observed that the water which will flow from tunnels and shafts, excavated here in the processes of mining, will possess little or none of the qualities belonging to the surface waters which dissolve away from every rain-fall the soluble saline matters that capillarity, aided by the powerful evaporation of a semi-tropical sun, concentrates upon the surface of the earth. This evil of bad water may therefore be expected to disappear with the active prosecution of mining enterprises.

Climate and healthfulness.—Under a previous head the climate of the Colorado has been characterized. The San Francisco District, being elevated some 1500 feet above the river, is less fervid during the hot months, the temperature averaging about ten degrees less than at Fort Mojave. The months of June, July, and August, are, however, extremely hot, and all active work in the open air, unless in the early morning or at evening, is interdicted, the temperature ranging in the neighborhood of 100° F. The air is extremely dry, 30° to 40° at times marking the difference between the wet- and dry-bulb thermometer. This circumstance favors exertion by lowering the temperature of the human body. Deep mining will, however, offer a refuge from the tropical summer heats, rendering labor agreeable and supplying also water of a lower temperature and better quality than can be found at the surface.

In point of healthfulness no region can be more free from diseases than this. I ascertained by enquiry from the physician at the military post that there were literally no climatic diseases known on that portion of the Colorado.[4] Malaria is unknown, and fevers equally so; chronic diarrhea occurs rarely, and then is traceable to causes independent of climate. This healthfulness may be considered as nature's compensation for some of the privations incident to this fervid region. The effect upon the urinary organs, due to the use of the saline waters of the desert, disappears immediately upon the use of the river water or any other pure water, and is always under the control of vegetable acids and of moderate doses of alcoholic stimulants.

[4] See note (3), page 291.

Cost of transportation and labor—The important elements of cost in mining upon the Colorado river and its adjacent district are labor and freight. The former is found to be about the same as in Virginia City and Nevada territory generally, viz., from $4 to $5 per day. So far as present experience justifies an opinion —no considerable amount of active mining having been done here—there is no dearth of labor. Most of the miners who have gone to this country have gone in the capacity of "prospectors" or adventurers, and are to a great extent owners of claims as well as laborers. This is in accordance with the general experience of all new mining districts on the Pacific coast. These bold and adventurous men have often been the pioneers of discovery, and subsequently the authors of the laws and regulations of the mining districts which their own sagacity and industry have developed, and in the organization of which they become officers as well as co-laborers.

Freight, by sea from San Francisco, costs now about four cents the pound, or eighty dollars a ton. The cost by land over the Mojave Desert is much greater; and nothing but the saving of time will justify the use of the Los Angeles route, and then only for the lighter descriptions of freight such as food and the smaller mining supplies. The time by sea up the Gulf of California is about three, not unfrequently four months. Over the Desert the time by government teams is 78 days from Wilmington or San Pedro to Fort Mojave. The navigation of the Colorado is continually improving, especially by the introduction of a class of steam vessels better adapted to this service. The shifting sands of the river, and the high tides—about 25 feet at its mouth—will, however, always make this navigation difficult and uncertain; and the low water of the river in the winter months occasions not unfrequent interruptions in the navigation. All these causes continue to render it highly desirable to improve the Mojave desert road by the establishing of more frequent watering stations, a thing believed to be quite feasible,—and by the improvement of the road itself by the removal of obstructions.

The agricultural capacities of the bottom lands of the Colorado remain to be developed. The Indian tribes now resort to them for the growth of corn, wheat, beans,—of most excellent quality,—yams or sweet potatoes, melons and pumpkins. The native Mezquit bean (*Cercidium Floridium*), and the 'screw bean' (*Strombocarpa pubescens*), furnish excellent food for animals, and is largely consumed by the native tribes for their own support. There can be little doubt that both corn and other grains for stock can be raised here for the wants of a considerable population, as well as all the esculent vegetables and most important fruits. At present the best lands are occupied by the

Indians, from whom, by purchase or treaty they can soon be obtained. In respect to agricultural capacities this region is more favored than most of the mining districts of Nevada, and may be in a good degree rendered self-supporting.

General features of the Geology of the District and successive epochs of eruptive rocks.—The rocks of this District are exclusively porphyritic or volcanic. The porphyry consists for the most part of the feldspathic variety, the crystals of feldspar being implanted in a violet or lavender-colored paste of various shades. Like most of the porphyries observed in the great American desert, for example at Virginia City and at Esmeralda, at Bodie and in the Mojave desert, these rocks yield to atmospheric influences, either crumbling into incoherent masses or breaking away into acute and fantastic cliffs. The porphyries in the San Francisco District are of at least two distinct epochs. Along the right-hand branch of the arroya of Silver Creek for the distance of a mile or more, occurs an olive-green, sometimes leek-green porphyry, in which are imbedded—like boulders in a conglomerate—large masses or fragments of the violet-colored porphyry and of other associated plutonic rocks; for example masses of basalt and diorite. This fact leads us to the conviction that the greenish porphyries are of more recent age than the violet-colored ones whose fragments they contain; fragments identical in character with the violet-colored porphyries which constitute the main mountain masses of the district. As the quartz lodes of this region,—for example those gigantic dikes known as the Moss and Skinner lodes,—contain imbedded in their mass, especially at their surface, fragments of scoriaceous lava, and present in general a burned and roasted appearance, I am led to the conclusion that not long subsequent to the time of their separation from the masses of porphyry through which they cut, there was a general and violent volcanic action resulting in the upheaval or injection of many dikes of basalt, diorite and olive-green porphyry imbedding fragments torn from the older rocks as already described. That this period of activity was general and simultaneous for this region, seems almost certain from the fact of the parallelism of the east and west lodes, as well as from their mineralogical and metallurgical identity, so far as present observation and exploration justify an opinion.

A second period of eruption appears to be clearly indicated by the existence of the second class of lodes already noticed, namely, the calcareous lodes, whose main course is northwest and southeast, and the mineral constituents of which are entirely unlike those of the east-and-west lodes. There is evidence also in this district, as well as in the country at large, of volcanic eruptions of a much more recent date than those which have given origin to the mineral lodes. This evidence is seen in the

cappings of basaltic lava which surmount many of the hills with plane tables, or which occur in parallel bands, interstratified with masses of volcanic tufa, sometimes of enormous thickness. We have no data for fixing the epoch of this third class of volcanic phenomena, but it seems clear that like the two others it was sub-oceanic; and in this respect all three are distinctly separated from a fourth and extremely well-marked group of similar phenomena which were plainly sub-aerial, and which occurred, geologically speaking, at a very late period, after the surface topography had assumed its present features. To this fourth class of volcanic phenomena we refer those extinct cones, so conspicuous just east of the Organ cañon of the Mojave,—cones whose lava streams now stretch their rugged course in long and regular inclined planes to a distance of eight or ten miles from the craters, standing with vertical basaltic walls ten or twenty feet above the plain, capped with scoria whose surface still speaks of the sluggish nature of the once molten mass.

Characteristics of the Mineral Veins.—The first thing which arrests the attention of the mineralogical observer in the San Francisco lodes, as compared with those of most other regions, is the general absence of the metallic sulphurets, and of the carious or porous character so common in the outcroppings of quartz in most auriferous regions. In this respect the San Francisco outcroppings are not unlike those seen in some portions of Nevada. There is reason to believe, so far as our own observations have extended, that this character of the outcroppings of the quartz lodes in San Francisco District is common to most the outcroppings in the porphyritic or plutonic rocks of other mining districts in Arizona; as in the districts of Eldorado Cañon and the Wauba Yuma. The larger lodes of the San Francisco District, such as the Moss and Skinner, are characterized also at surface by a cross structure at right angles to the general course of the lodes, breaking them up into a series of subdivisions or headers which include often large masses of the adjacent porphyry walls, or of other rocks more or less distinctly volcanic. Whether it is due to the volcanic action to which the surface of these lodes has been subjected, or to some other less probable cause, it is a fact that most of the lodes in this district show an absence of the fringe or lining of fluccan or clay material, generally found in softer rocks. The lodes of this district are in general glued fast to the adjacent walls of porphyry, but that this characteristic is only superficial seems probable from the fact that the Allen shaft, sunk upon the Moss lode, intersecting the line of its southerly or hanging wall shows a distinctly marked fluccan or fringe, separating the vein from the adjacent porphyry at a few feet depth from the surface,—although at the surface no such struc-

ture was visible. The surface of the quartz also, at this portion of the Moss lode has the appearance of having been burned, looking like quartz containing pyrites which has been roasted in the fire and then quenched in water, leaving the surface deeply stained with red oxyd of iron; this stain penetrating by numerous rifts and fissures to a considerable depth from the surface. It was in quartz of this description that the extremely rich samplings of gold were taken which have rendered this lode famous. In similar quartz from this portion of the Moss lode, I found it still easy to obtain rich specimens. The inference is that the surface of these lodes has been subject to the action of heat, probably through hot waters, dissolving or decomposing the metallic sulphurets and leaving the superficial portion of the lodes in a hardened and changed condition, unpromising for metallic value, but giving place in depth to vein stuff of a softer character, and more charged with metallic sulphurets. This change is very conspicuous in the Techatticup lode in Eldorado cañon which has been open to a depth of 140 feet, and shows, as I am informed by Henry Janin, a gradual increase to this depth of metallic sulphurets, from a condition at surface of a quartz lode destitute of these compounds. On the Moss lode a shaft of 52 feet has shown a similar change in the relative hardness of the including walls of porphyry, and the gradual softening of the contents of the vein. As yet the explorations in the San Francisco District are quite too limited in depth to enable us to apply this reasoning with certainty to any number of the lodes, and it is by analogy only that the conclusion is reached which seems to warrant this probability.

Mineral contents of the lodes.—The Moss, Skinner, and in general the larger lodes of the San Francisco District, are characterized by the presence of an abundance of white feldspar, forming sometimes the mass of the vein; the quartz existing then as a subordinate vein in the feldspathic and porphyritic gangue.

The mineral most characteristic of the east and west lodes in the San Francisco District, next to the quartz and feldspar which form the great mass of the lodes, is *fluor spar*, a mineral frequently seen elsewhere in the world as an associate in silver-bearing lodes—as, for example, in Freiberg in Saxony—but which is of rare occurrence in this country in a similar association. This mineral is found abundantly in the Skinner lode, the Dayton, the Knickerbocker, and the Quackenbush; and has been observed also in the Moss and several others. It is associated in them with free gold, horn silver sometimes in distinct dodecahedral crystals, and iron gossan.

Description of some of the veins of the San Francisco District.—In general the lodes in San Francisco District are remarkably vertical, rarely deviating more than 30° from the perpendicu-

lar; and their outcroppings are commonly very strong and well marked, forming, in the case of the larger lodes, conspicuous features in the topography of the country—landmarks seen for many miles.

To describe all the lodes in this district would be tedious and unprofitable. The amount of work performed on them has in general been no more than is essential to conform to the easy conditions imposed by the laws of the district upon claimants; and has in most cases been too little to furnish important data for the guidance of the judgment. I shall therefore confine myself to those which are best developed or of the most general interest and importance, commencing with the Moss lode, which has received more attention than any other one of the San Francisco lodes.

Of the Moss lode.—The outcroppings of the Moss lode form a most conspicuous feature in the landscape, being seen, standing up in bold crests and pinnacles, from a long distance. The observer who enters the Colorado valley from the Mojave Desert has his attention arrested by the crests of the Moss lode, as soon as he emerges from the valley of Pah-Utah creek, at a distance of at least twenty miles in an air line. This lode stretches in a continuous line for at least 7,800 feet, and is 'claimed' for double that distance. Its distance north of Silver creek is about two miles, and its course is about W. 5° N., or nearly at right angles to the river, from which it is distant about five miles. This vein shows at surface about fifty feet of thickness, as well as can be judged in its present state of development, while its croppings rise to a height of from fifty to one hundred feet or more above the arroya or wash, sinking at times to the surface and then towering away again in bold peaks and crests. Its height above the Colorado must be at least 1500 feet. Its dip is southerly 65° to 70°, or 15° to 25° away from the vertical. The weathered aspect of this vein is reddish and rich brown, but on breaking away the weathered surfaces it is found to be composed of whitish compact feldspar and quartzose porphyry, intersected by veins of very red, often marbled quartz, at times violet-colored, and rich in free gold. There are included in this vast mass, not merely numerous sets of feldspar, hornstone, and quartz veins, but also masses of gray porphyry and lumps of tufaceous and vesicular lava, indicating the action of heat, either of thermal waters or of direct volcanic agency. Some masses of a cellular structure have the vesicles filled with hyaline quartz or hyalite,—possibly also with some zeolite—and these masses so resemble the siliceous sinter of Steamboat springs in Washoe valley, as to recall at once the probability of a thermal origin. This probability is further strengthened by the occurrence of veined and marbled jaspers and hornstones. Drusy

surfaces of crystalline quartz are also seen abundantly in all the "shuts" or closures of the vein.

The hanging wall of the Moss lode is an ash-gray feldspathic porphyry, often intersected by thread veins of quartz and hornstone, but barren of metallic sulphurets, and showing at the surface no clay wall or fluccan, separating it from the vien. The absence of this character of permanent and well defined lodes at the surface of the Moss ledge is in analogy with the character of many veins in Nevada, which, however, at moderate depths acquire this feature, as the Allen shaft shows to be the fact for the south or hanging wall of the Moss lode. The entire outcrop on the Moss lode has a burnt up, dried and hardened aspect, as previously explained; and this character is shown now by very moderate explorations, to be quite superficial.

The characteristic veinstone of the Moss lode is feldspar with veins of chert or hornstone, in which matrix occur veins of highly ferruginous quartz, sometimes almost an iron jasper of various colors, sometimes compact and again cellular. The surfaces of closure are drusy, not separated from the gangue by any parting, but cutting it with a dip usually more highly inclined than the dip of the vein itself. These intercalated or subordinate veins of quartz appear to maintain a course quite parallel with the main vein. Too little work has however been done on the lode to justify this generalization in any more than a limited sense, as far as can at present be seen.

The rich specimens of free gold in quartz, of which over a ton weight were taken at one time in 1864, were obtained on one of these subordinate veins of deep red iron-stained quartz, just behind the point on the so-called San Francisco claim where Allen's shaft is now being sunk. I caused some blasts to be put in at this point and was able to obtain a considerable amount of quartz of similar character, highly charged with gold. That the gold is not confined to this point I found by breaking some specimens at several points along the face of the outcrop for a distance of 250 feet; and it is easy to detect minute particles of the precious metal along a line of 500 feet, by careful observation.

The Moss lode has been opened by a shaft called Allen's shaft, sunk on the San Francisco claim, ten or twelve feet in front of the spot where the first lot of rich ore was obtained, to a depth, in Aug. '64, of 42 feet. This shaft was set to cut the hanging wall of the lode and pass through its entire thickness in an estimated depth of about 100 feet. Where it cut the southern edge of the lode ore was found from which an assay was obtained, showing $4,200 per ton of precious metals.

I ordered this shaft cleaned up, to exhibit the nature of the section it has furnished of this side of the lode. The result was

interesting: the "pay streak" or productive ore ground is seen to be here about three feet wide in two nearly equal divisions, separated by about one foot of soft yellowish and reddish material, which prospects well for gold. This softer seam has come in on sinking and is not seen at all at surface. It is increasing in width as the shaft descends and is easily worked by the pick alone. Its dip is such that it passes out of the shaft in twenty-seven feet, the shaft being eight feet wide. The hanging wall is perfectly definite and shows smooth "slickensides," with a clay lining between them in places from three to four inches in thickness. The upper-rock is a reddish feldspathic porphyry, with thread veins of quartz. The vein stuff shows very little sulphurets and the porphyry comes in between the walls. The quartzose ground increases as the shaft descends, until at its present bottom it is nearly all quartz.

The bullion obtained from this vein contains silver enough to give it a pale yellow color. The gold appears in beautiful polished scales, the flat surfaces often embossed with crystalline lines. The precious metal is sometimes imbedded in a compact red jaspery quartz, presenting, when cut and polished, beautiful graphic goldstone. This rich gold-bearing mass of ferruginous quartz it will be understood formed the outcrop of this gigantic vein at only isolated points. Subsequently having an opportunity of comparing the physical features of the Moss vein with the surface show upon the "Comstock lode" in Nevada, I was forcibly struck with the great resemblance of these portions of the Moss vein with that portion of the Comstock which is still seen at Gold Hill, south of Virginia City, where similar rich deposits of low grade gold in the quartz outcrop gave its name to the town which has since sprung into such wonderful activity as the result of the development of the mines which have been opened upon this remarkable silver vein. The inference seems probable that the explorations of the Moss lode will likewise develop a silver mine, and if the magnitude of the outcroppings afford any just ground of comparison, the future of the Moss lode should not suffer in the contrast. But there is this important feature of difference, the rich sulphids of silver associated with native silver which were found in such remarkable abundance in that part of the Comstock, now known as the Ophir ground, has never been seen on the Moss lode.

I am permitted to copy the following certificate of assay and experiments with sodium amalgam made by Dr. Torrey & Son on a sample of ores taken from the rich 'chimney' of the Moss lode. The sample in question was collected in the summer of 1863 by Mr. Chas. W. Strong, who is now engaged in an active exploration of this interesting locality on behalf of a party of New York capitalists:

U. S. Assay Office, New York, Feb., 1866.

Sample of ore from Arizona Territory.

Weight of sample 34 lbs. 14½ oz. Bullion obtained $59·04.
By assay the bullion contained in 1000 parts,

Gold,	682
Silver,	308
Copper,	010
	1000

The value per ton by assay is $3,572.00

a. After treating the ore by *panning* to remove the coarser portions of the free gold, the remainder was subjected to a series of experiments to test the comparative value of amalgamation by ordinary mercury and the Wurtz process with sodium amalgam.

First the tailings of *a* were assayed and gave,

Gold per ton,	$1072.00
Silver "	60.00
	$1132.00

b. 8 lbs. of the ore (tailings) were amalgamated with ordinary mercury, and the bullion obtained weighed 2 dwt. 14 grs., which assayed as follows:

Gold,	706·5
Silver,	291·0
Copper,	2·5
	1000

Value of Gold obtained from *b*: $1.88=45 pr. ct. of fire assay.
" Silver " " .04
$1.92

c. 8 lbs. ore (tailings) were treated with sodium amalgam, (Wurtz process) and the button obtained weighed 4 dwt. 11½ grs., which gave by assay

Gold,	705
Silver,	146
Copper,	149
	1000

Value of Gold obtained from *c*: $3.26=78 pr. ct. of fire assay.
" Silver " " .04
$3.30

The total quantity of gold in 8 lbs. of ore by fire assay is $4·19.

Jno. Torrey & Son.

The assays of samples of the ore of this vein collected by myself and others, show a value of from $70 or $80 to several thousand dollars to the ton of 2000 lbs. But all such results

are of little value compared to the actual reduction of large quantities of the ores in working processes.

Other lodes of this district.—My notes contain mention of over fifty lodes or veins, most of them probably distinct, which I visited in the course of my explorations of the San Francisco district, and which belong to the east-and-west system. The parallelism between the lodes of this system is almost exact, and there is a great similarity in their mineralogical character.

The 'Skinner,' on the south side of Silver Creek, is one of the most conspicuous, forming like the Moss lode bold and fantastic crests, rising sometimes in slender needles to a remarkable height. The boldest outcrop is called the "center claim," of 1600 feet. But those portions called the Rochester (1800 feet) and the San Francisco (2400 feet) are nearly as bold. This lode shows drusy quartz, both compact and cellular and ferruginous with numerous cavities where fluor-spar has been weathered out. Hornstone is also seen frequently. Very small traces of sulphids show at surface, which is much stained by black oxyd of manganese, rendering portions of the outcrop quite black.

This vein varies from 50 to 150 feet in thickness. Its walls of ash-colored feldspathic porphyry are seen in places beautifully polished on the line of the dip 70° N. It appears glued first to the porphyry, without a lining of clay, (fluccan), but this is so commonly the case in the outcrops of Nevada that it is no proof of the absence of this important character of a true vein at a moderate depth.

An exploratory shaft has been sunk near the center of this claim on the foot wall, at a point designed to cut the lode at the depth of 100 feet, but at a depth of 50 feet the resources of the explorer gave out. Eighteen feet of water in this shaft confined my observations to the materials thrown out, showing the correctness of a statement made to me, that a branch vein or offshoot of the main vein had been cut, carrying green and purple fluor in octahedrons in a quartzose and feldspathic gangue, with occasional gray spots of minutely diffused sulphid of silver. Three assays of the ore from this shaft proved the presence of silver to the value respectively of $25, $74, and $83 to the ton of 2000 lbs. From a second shaft sunk on the N.E. side of the wash, in the body of the vein, to a depth of 25 or 30 feet, I obtained beautiful octahedral crystals of green, white, and purple fluor spar. The gangue and the whole mineralogical character of this vein, so far as explored, is of the most promising character, and it offers a most legitimate field for judicious exploration, with a reasonable expectation of the discovery of silver ores in remunerative quantity. At the same time it must be remembered that such an exploration is sure to be costly and its result is always doubtful.

The Parsons, Hurst and Leeland are other gigantic lodes,

south of the Skinner and of generally similar character, but, at the time I saw them, almost completely unexplored.

Some of the smaller lodes of this district appear to me to offer the hope of a much less costly exploration, and with the promise of quicker returns. Of this class I may mention the Caledonia and Dayton, a few hundred feet south of the Moss lode, and the Quackenbush and Knickerbocker, some distance south of the Skinner and Parsons. These veins are from three to ten feet in thickness, well defined, and showing at surface all the characters of true metalliferous veins. Besides well characterized and abundant iron gossan in cellular quartz, I observed in them fluor spar, feldspar, green carbonate of copper, horn silver, and free gold. Samples from these outcrops, collected by myself, yielded when worked in an experimental mill, from forty dollars to two hundred and fifty dollars per ton of two thousand pounds.

In no other mineral district which I have seen are there so many remarkable outcroppings of quartz veins carrying the precious metals, crowded into so small an area and on a scale of such magnitude in development as in the San Francisco District.

In the vicinity of Austin, (Reese River) Nevada, the veins are more numerous, probably, but are also much smaller and quite inconspicuous, having, in fact, almost uniformly no outcrops to attract the attention of the explorer.

Both districts are situated in a desert and inhospitable region, but the fervid heats of the Arizona summer are fully counterbalanced by the severe cold and snows of the more northern locality. Supplies can be brought with tolerable certainty by sea and river to Hardy's Landing, immediately in front of the San Francisco District, and within five miles of the Moss lode.

With these facilities for development we ought not to remain long in ignorance of the true character in depth of these very remarkable mineral veins, nor is it too much to hope that they will, with an honest and prudent use of capital reward the adventurers with handsome returns for the capital employed in the exploration.

Of neighboring mineral districts.—My observations extended east of the San Francisco District to Trout Creek, a branch of Bill Williams' Fork of the Rio Colorado, where there is a mineral district called the Wauba Yuma, about 60 miles east of the Colorado, and in a region entirely beyond the present limits of civilization. Passing the range of Boundary Peak, over a crest of volcanic tufas and red porphyry rocks of some 1500 feet elevation at the point of crossing, above Allen's Camp, or over 3000 feet above the river,[8] the traveller descends eastwardly in

[8] The peaks on either side of the pass are, however, much higher, but I had no opportunity to measure them by the barometer.

a dry valley, called Massacre Valley, from the sad tragedy of the murder of a large party of Texan and Arkansas emigrants in 1857 by the Mojave, Wallupi and Pah Utah Indians. We found the melancholy evidence of this catastrophe scattered along the line of Beale's Road for several miles, over seventy persons with their teams and baggage wagons having been destroyed. The bleaching bones of the oxen, half burned remnants of waggons, with cooking utensils and household furniture scattered about or lying as they fell, attest the savage ferocity of these treacherous tribes. About twenty miles beyond the easterly margin of the San Francisco District, there is an entire change in the geological character of the country. The porphyritic and volcanic rocks give place to metamorphic schists, gneiss, and granitic rocks abounding, with numerous veins of white quartz. From the Rio Colorado to the eastern limit of the Massacre Valley, 30 miles or more, the rocks are entirely porphyritic or volcanic. The same rocks which are seen on the west side of the Colorado are repeated here. The mountains possess a fantastic, almost grotesque outline, due, probably to their peculiar mode of decomposition. Many needle-shaped porphyritic masses adorn the ridge and are thrust through horizontal and gently inclined beds of volcanic tufa and cement of various striking colors, usually light, sometimes almost white, variegated by zones of brown, red, chocolate, and yellow. Large blocks and irregular fragments of volcanic or basaltic rocks, usually black or deep brown, are seen implanted in the overhanging and undercut cliffs of tufa and cement 250 to 300 feet high along the narrow gorge through which the trail crosses the crest, near "Meadow Springs." These volcanic beds appear to be of sub-aqueous origin. All the loose river drift and boulders on the plane are cemented into a firm concrete with a white cement derived probably from these beds.

The change in the geology of the region is very marked in the transition from volcanic rocks to those of the granitic family, and is accompanied by a corresponding change in the character and direction of the mineral veins, and the commencement of a region better wooded and watered than that previously described. Near the western margin of the Wauba Yuma District occurs a considerable vein of auriferous quartz, accompanied by ores of copper and sulphurets of iron. It first appears in a pretty high granitic mountain to the northwest, and its course has been traced about three miles to the southeast. This lode, which has been called the "Pride of the Pines," appears to be about ten feet wide, and possesses promising characteristics. The sample collected by me, although showing no free gold, yielded $30 to $50 to the ton of assay. It possesses the characteristics common to the auriferous lodes of the Sierra Nevada, and the same general N.W. and S.E. direction, while, it will be remembered,

the silver veins of the San Francisco District are nearly east and west in direction.

The granitic range in which the "Pride of the Pines" vein occurs extends for at least fifty miles, in a line nearly north and south, and forms a mountain mass of no mean proportions. Its altitude I could only conjecture, having sent my barometer in another direction, and crossing the ridge only at subordinate points. Its crests, however, may be from five to six thousand feet above tide.

Immense drift deposits of angular fragments without arrangement occur upon the flanks of this range, and so greatly resembling in their character glacial moraines as to command my careful notice. In a dry arroya which had been cut by torrents through this ancient drift, I saw for two and a half miles a section, averaging perhaps one hundred feet in depth, of the mass of one of these moles of glacier-like materials, chiefly angular fragments of granite, some of quite large dimensions, mixed with smaller angular fragments, sand and mud, with no trace of arrangement or stratification whatever. These moraines (if they are such) are of all dimensions, from one mile to eight miles in length, some of them as regular as a rail-road embankment and forcibly recalling those of unquestionably glacial origin jutting out upon the American Desert from the eastern escarpments of the Sierra Nevada near Mono lake, Aurora, and between Wellington's and the Palmyra districts.

These Arizona mounds run southeast from the main mountain mass, in lines seemingly parallel but really radii of the mountain valleys or gorges, between which they occur, falling away in gently inclined planes from the ridge. On their outer edges some traces of stratification appear, as in river drift, but this appearance seemed plainly a partial rearrangement of the materials by the torrents to the course of which they are limited. I record the observation with the impressions made at the time. My field notes contain the remark "true glacial drift." The latitude was about 35°, lower than true glacial phenomena have been recognized, if I am correctly informed. There were no exposed surfaces of rocks to show glacial scratches, and the exigencies of travel in this difficult region did not permit me to ascend the rocky peaks in search of them.

These alluviums, whatever their origin may be, cover an area ten miles to fifteen miles in width, going east of Pine Mountain ridge to the next and parallel ridge, which I have in my notes called "Castle Ridge." The recurrence of volcanic rocks and wide spread sheets of basaltic lava, as a capping to the mountains and hills, gives it a character entirely in contrast with the familiar features of the metamorphic and granitic mountains just noticed. These features are especially seen in a lofty table mountain of the 'Castle Ridge' on the traveller's left, as he leaves

Pine Mountain ridge behind him. This bold land-mark I named in my notes "Mount Brewer." "Fortress Rock," on Trout Creek, is another fine example of the same kind, but the valley north is filled with similar table mountains from a few hundred to a thousand or twelve hundred feet above the surrounding country. Here the same horizontal and gently inclined beds of light colored tufas already noticed as occurring near Silver Creek, fifty miles or more west of this, recur and are capped in a like manner by basaltic columns.

Enormous dikes or reefs of quartz and of coarse quartzose feldspathic granite cut through the reddish gneissoid granite which forms the basement rock over a large part of the Wauba Yuma District, rising in one case 100 to 150 feet above the cañon which cuts the vein at a point where I examined it, and where it is 50 feet thick. I could not discover in those gigantic veins much evidence of any metallic value, nor had there been any exploration upon them.

The Sacramento District, about 45 miles N.E. of Fort Mojave, I did not visit, but inspected a large collection of argentiferous galena from its veins, made chiefly by soldiers of the Post. These lead veins occur in metamorphic rocks, and are such in size and metallic value, so far as I could learn, as to lead to the belief that they will one day be worked when labor and supplies are cheaper and more abundant, and they may furnish a most important auxiliary to the treatment of the silver ores of adjacent districts.

The Irataba district, south of Fort Mojave, comprises a number of veins carrying copper, but few of them, in the opinion of my assistant, Mr. Frank Sample, who visited them, are worthy of exploration.

ART. XXXVII.—*A method of Giving and of Measuring the angles of Crystals, for the determination of species, by the use of the Reflecting Goniometer;* by JOHN M. BLAKE.

IT seems desirable that more general use should be made of angular measurements of crystals for the purpose of determining species, than the ordinary methods of measurement and comparison will allow.

The time and study required to understand the various forms of symbols adopted by different authors, and then to locate the planes on the given crystal before making the measurements, make the pursuit of the subject in this way a difficult matter, even to those who have spent considerable time in the study.

Now it is possible to describe a crystal, giving measurements which will locate every plane occurring upon it, without the use

of symbols having reference to any system of crystallization. By thus making the measurement of a crystal, simply a mechanical operation, this description will be sufficient to determine again the same species, so far as it can be done by angular measurement of the planes.

The method consists in taking advantage of the existence of certain natural laws, which determine the arrangement of the planes upon a crystal into zones; and noting the angular distance of each plane in a zone, from one of them fixed upon as the starting point; this to be done by simply giving the goniometer-reading for each plane; and, further, binding all of the measured zones together by noting a sufficient number of their points of intersection.

Since a zone is a number of planes making parallel intersections with each other, if we adjust any two of the planes for measurement, we have at the same time adjusted all, and can readily go on and record the reading of the instrument for each plane.

We thus preserve the relative position of the planes, which gives the measurements a value which cannot be attained by the ordinary method of separate measurements, for the location of which we have to depend upon our knowledge of certain symbols.

It can be seen that there is thus a saving of labor, and of space in recording, if we consider that the object in view is to get a *complete* measurement of a crystal.

This measurement of zones may be carried to an extent which convenience will determine for each species. Four or five zones will often include nearly all the planes on a crystal, perhaps all that would be actually needed for the determination of species. To bring in the remainder, to complete the description, it may be best to make separate measurements; or to give only portions of zones, where to give the complete zone would be an unnecessary repetition of what had already been well noted.

To show what can be done by this method, suppose in the case of sulphate of copper, ($CuOSO_3+5HO$) each plane to have its opposite, there will be more than twenty-eight planes upon a complete crystal.

All of these planes can be brought into three zones intersecting in a common plane (*b*, of Rammelsberg).

It will be necessary to add a fourth zone, crossing the others, to bind them together and make the description complete. The species, sulphate of copper, is selected, because it belongs to the triclinic system of crystallization, and therefore it might be considered more difficult of description than the average of species, and the remeasurement of a crystal for comparison, an op-

eration requiring considerable patience, to say the least; but by the use of this method it becomes in either case a comparatively easy operation.

If, from the description, the angle be required between any two planes lying in one of the measured zones, it can be readily obtained by subtraction. But if the planes do not both lie in one of the measured zones the angle can be found by means of spherical trigonometry, without taking into consideration symbols or axes.

The prismatic zone in elongated crystals would be the first to measure, because best developed.

We can start with the zero of the instrument opposite the largest plane if we have no other guide.

The other zones may be taken in the order in which they appear best developed. Some order is desirable to facilitate the use of the description for future comparisons.

In using the description for determining species, after measuring the most obvious zones on the crystal, we can plot them on paper and turn the protractor until the readings coincide with the description.

The plotting is necessary only when there is difficulty in making the comparison, on account of the zero of the instrument not having been brought opposite the plane used in the description.

When we have found a coincidence of readings for a zone we have determined all the planes in the zone; also the symbols, if given in the description.

In this way, with a description in this form, we can speedily determine all of the given planes which occur upon the crystal before us; also if there are any new planes.

Care should be taken not to confound right and left hemihedrism, or similar non-superposable forms, which is liable to be done if we do not note the relative position of at least three planes, not in one zone. In case a drawing is given, this will not be necessary.

The use of this method gives us a great advantage in detecting and measuring accurately very small planes and cleavages, which, were it not for the fact that they come into the zones, could not be adjusted for measurement on account of the feeble reflection which they give.

Note.—Direct sunlight is of great value in detecting and measuring small planes: the light may be tempered by means of smoked glass.

For convenience in approximate adjustment when using a Wollaston's goniometer of the usual form, and to make it possible to measure entirely around a crystal, it will be found an advantage to mount the crystal at the extremity of a lead wire, of three or four centimeters in length, and for most crystals one millimeter in diameter.

A method for the rapid and easy adjustment of a crystal for measure-

ment, in the Wollaston goniometer is, first, to bring one plane parallel to the motion of the joint between the two L's, so that motion of this joint will not affect the reflected image, and then to use for adjusting this plane only the motion of the rod carrying the crystal, while, for adjusting the other plane, motion of the joint only is to be used. By observing these points, from two to four movements only will be required to obtain perfect adjustment; while if we neglect them there are certain positions in which the planes may lie with reference to the adjusting motions, which will make the adjustment a tedious operation.

New Haven, Dec. 14, 1865.

ART. XXXVIII.—*On the Quaternary Formations of the State of Mississippi;* by EUG. W. HILGARD, Ph.D., State Geologist of Mississippi.

IN my Report on the Geology and Agriculture of Mississippi, printed in 1860, I have given my observations on the Quaternary formations of the state. (See pp. 5 to 46, and 194 to 201, incl.) I now desire to present some general considerations on this subject, which in the place referred to could find but a brief mention or discussion. In so doing I shall not reiterate in detail the facts and observations recorded there, but in mentioning them will refer the reader to the corresponding paragraphs of the published volume. Having been for several years past deprived of all scientific intercourse, I desire to enter beforehand a disclaimer as to any intentional plagiarism, should some of the views and questions here presented have been meanwhile discussed and perhaps settled by others.

I have stated (§ 326) that, aside from the Alluvium proper, attributable to causes still in action, there are four distinct stages of the Quaternary recognizable in Mississippi, to wit:

1. The "Orange Sand."
2. The Bluff or Loess.
3. The "Yellow Loam."
4. The "Hummocks," or Second Bottoms, which I shall consider in the order of their age.

The Orange Sand.—I am not aware that a formation of precisely the same *ensemble* of character as this, exists outside of the States of Mississippi, Alabama, Tennessee, and small portions of Louisiana, Kentucky and Arkansas. Its existence in the latter two states is apparent from observations recorded in various places in the reports of the geological surveys of Arkansas and Kentucky; more especially does the description given by Dr. Owen of Crowlegs ridge, Greene county, Ark., agree closely with the usual facies of the formation as observed by myself in Mississippi, and by Prof. Safford in West Tennessee. In Alabama it

is characteristically developed in the northwestern portion of the state, on the waters of the Buttahatchie, Looxapalila, and Sipsey. It is not specially so described in Tuomey's Alabama reports, from the accidental circumstance of his never having personally visited that portion of the state, which afforded no prospect of important practical discoveries; but I have traversed the region in 1856, on a visit to Tuscaloosa, a few months before Prof. Tuomey's untimely death.

Prof. Safford, in his First Biennial Report of the Tennessee Survey (p. 162), classes his "Orange Sand Group" as a member of the Cretaceous formation; without, however, claiming as final results, this as well as other opinions derived, as he himself states, from a mere reconnoissance. Having been unable to procure a copy of his later report, I am not aware whether or not, on reëxamination, he has changed his views on this point, as I have no doubt he would upon a fuller investigation of the facts of the case, such as they force themselves upon the attention of a geological observer in Mississippi.[1] From the few data given by him *l. c.*, though they can leave no doubt as to the identity of the formation, I am unable to judge whether the "bed of greensand" mentioned by him, together with the underlying lignitic clays, are referrable to the Ripley and Eutaw Groups, or to the "Northern Lignitic" of my report, which as there stated (§ 166), is sometimes glauconitic in its highest member. The greensand of McNairy Co., Tenn., is unquestionably Cretaceous; Safford's Lignite Group is, doubtless, the continuation of my "Northern Lignitic"; but he has failed to identify the Orange sand with the "Drift series" underlying the Bluff formation on the edge of the Bottom. Considering the highly complicated relations often existing between the Orange Sand and the underlying Cretaceous strata (as exemplified §§ 33 to 40, *et al.*), the occurrence of Cretaceous fossils in the ferruginous sandstone capping the hills, and the appropriation of Cretaceous material, almost unchanged to the formation of strata most unequivocally connected with the Orange Sand, the misapprehension of Prof. Safford is extremely natural. It requires, indeed, all the closeness of research which necessity imposes upon the geologist in Mississippi, to convince one's self of the identity of this capricious formation under all its forms, the knowledge of which I am even now far from satisfied of having exhausted.

The Orange Sand, as my observations show, overlies in Mississippi formations reaching from the lowest Sub-carboniferous slate (Saff. 1st Rept., p. 158) through the Cretaceous and Tertiary to a group of deposits on the Gulf coast, which so far I have found to contain only living species, and am therefore inclined

[1] Prof. Safford refers the beds to the Tertiary in this Journal, xxxvii, 361, May, 1864, in an important paper treating of the "Cretaceous and Superior Formations of Tennessee."—Eds.

to consider of Pleistocene (or Quaternary?) age (§ 247, and ff.). All over this area, it contains, more or less, the fossils of the underlying formations, mostly *waterworn*; while the closest scrutiny I have bestowed on hundreds of extensive exposures, has failed to detect any fossil apparently peculiar to the formation as such. This might seem paradoxical enough to any one acquainted with the frequent occurrence of silicified wood in these strata; but it soon becomes quite obvious to an attentive observer, that the regions of frequent occurrence of this fossil in the Orange Sand, are coëxtensive with those in which fossil wood, either silicified (when imbedded in siliceous sands) or lignitized, occurs in the underlying lignitiferous (Cretaceous or Tertiary) strata. It is not at all unusual to find trunks of silicified wood imbedded partly in the unchanged lignitic strata, partly in the Orange Sand; the portion contained in the latter being nearly or wholly deprived of carbon, while the part imbedded in the lignitic material is, if at all silicified, of an ebony tint, and often contains pyrites (§ 26, *ad finem*).

While, therefore, I admit the possibility of a further specific determination of these silicified trunks assigning to the Orange Sand some peculiar species, I am convinced that the greater part, if not all of this fossil is derived from the underlying strata, and will be found represented in their flora. Wherever silicified wood does occur at a distance from lignitiferous deposits, it forms waterworn pebbles; and not unfrequently, layers of comminuted fragments of the same, form the line of contact between the older strata and the Orange Sand. (See for example, § 169, section 17.)

The lithological and stratigraphical characters of the formation, however (which in the absence of proper fossils must form our landmarks), are strongly marked, and the correspondence of many of its prominent features with those of the deposits of the Drift proper in the northwestern states, as described by Dr. Owen, Profs. Hall, Swallow and others, is manifest at a glance. The materials are essentially correspondent, and disposed in a similar manner; proving the action of violent currents and their concomitants—extensive denudation of the more ancient formations, appropriation and re-deposition of their materials with the irregularity of arrangement consequent upon the alternate existence of currents, eddies, slack water and counter-currents, in one and the same place.

The geographical distribution of this formation, as well as the total absence of any observable dips, where its strata are sufficiently continuous to admit of such determinations, clearly prove its deposition posterior to the epoch of upheaval which has given a sensible dip even to the latest Tertiary (if Tertiary it is) of the Gulf coast (§§ 250, 869). The main body of the formation

seems to represent an immense delta, whose apex is in the neighborhood of the junction of the Ohio and Mississippi. Its *eastern* outline descends along the ridge of Carboniferous rocks skirting the Tennessee valley on the west, and passing along the western outline of the Coal-measures of Alabama, reaches the Warrior river at or above Tuscaloosa. Thence the formation extends southeastward toward the Coosa, but the pebble belt, which generally so far has marked the eastern outline, seems to follow rather the course of the Warrior and Tombigby, coastward. In Alabama, however, as in Mississippi, it is but thinly represented on the territory of the "Rotten Limestone."

The extreme western outline of the delta is, doubtless, to be sought in Arkansas, skirting on the east the high lands of that state. That the great channel of the Mississippi, however, was already impressed upon the surface at the time of the deposition of this formation, is rendered obvious by the existence in it, parallel to that channel, of a belt of pebbles and coarse shingle, which at present reaches but a short distance (ten to fifteen miles) inland from the "bluff" or edge of the great bottom. It was deflected westward by the Tertiary ridge of the "Walnut Hills," abutting at Vicksburg upon the Mississippi, the latter having almost entirely cut away the pebble deposit; it reappears, however, below Grand Gulf, and thence again has spread southeastward across the state, so as to reach, in Marion Co., Miss., the waters of Pearl river.

While the Mississippi river is thus the legitimate modern representative of the great ancient current which was capable of transporting such coarse material, no *one* channel now remains to represent the corresponding stream (or bayou, as it would now be termed) on the eastern edge of the delta, whose existence in times past is certified by a similar band of pebble deposits now crossed in several directions by the drainage of the country it traverses. Unlike the loose beds of the western band, those of the eastern stream are often, if not prevalently, cemented into solid pudding-stones by a cement of brown iron ore; which circumstance may give some clue to the deflection of the waters from the ancient channel which now, on the contrary, forms a dividing ridge between the waters of the Tennessee and upper Tombigby.

Such being the general disposition of these deposits, we are led to inquire into the origin of the great inundation of water apparently devoid of organic life, by which they were formed. What traces of its existence has it left north of the latitude of the Ohio, whence the rush of waters evidently came? The northern geologist may pertinently retort: "What became of that rush of waters whereof our Drift furnishes the evidence, after it left our latitudes?"

Given, the Northern Drift: it appears to me that the *Southern Drift* is a postulate, so far as the surface conformation of the United States would admit of its deposition. And here we have a formation possessing, as we shall see, all the main features of the northern Drift, the differences being quantitative rather than qualitative—its age later than the latest Tertiary, yet anterior to the Loess. There are but two essential features to distinguish it from the beds of the northern Drift proper. These are, first, the absence, or at least, great scarcity of "erratic blocks" proper, *i. e.*, of fragments of rocks derived from distant localities and not, or but slightly, waterworn; secondly, the great prevalence, to the extent of characteristic feature, of limited deposits of ferruginous sandstone or conglomerate, which, however small their local extent, have by their resistance to denudation controlled the surface conformation of by far the greater portion of the State of Mississippi (§ 11 and ff.).

As regards the former point, it would seem to find a ready explanation in the *lower latitude* in which these deposits are situated. Whatever may have been the precise nature of the "Drift agencies," it cannot be doubted that arctic ice, whether icebergs proper, or shore-ice floes, were instrumental in the transportation of the sharp-angled fragments we find imbedded in the northern Drift deposits, innocent equally of the rounding action of water, and of the grinding and scratching one of glacier transportation. It is but rarely that, at the present time, the floating ice of the Mississippi river passes much beyond the latitude of Vicksburg; and it is difficult to conceive how even the largest berg should not, before reaching a latitude so low, have performed so many evolutions through the successive changes of its center of gravity, as to have dropped every vestige of moraine material. Yet some stout floe of shore-ice might be supposed to be capable of reaching this latitude without dropping all its passengers, some of which might be therefore expected to occur amongst the (otherwise invariably waterworn) materials of the southern Drift. And such in fact is the case, for, however rarely, a few large angular boulders *have* been found in the Orange Sand of Mississippi (§ 21). The block of milky quartz in the collection of the University of Mississippi, shows a surface almost as sharply angular and splintery as if freshly broken from its original place.

As to the second point, it amounts to a mere quantitative difference as to the extent of the process which, from Minnesota to the Gulf coast, forms ferruginous sandstones, claystones and conglomerates of various degrees of hardness, in the deposits of the Drift period. While in those of the northwest, the ferruginizing process has played but a subordinate part, and within the limits of the Drift itself, in Mississippi its action has frequently extended beyond the Orange Sand, into the underlying formations.

It has thus, for example, metamorphosed the white, leaf-bearing clays of the Tertiary, into the fine-grained ferruginous shales whose species have been in part determined by Mr. Lesquereux (§ 170, Sec. 18). Where the clays are less siliceous and consequently less pervious, the ferruginous solution, unable to penetrate, has aggregated into nodules of limonite ore (§ 42). On the territory of the Carboniferous, the ferruginous conglomerate of hornstone pebbles (which passes through all gradations of fineness into the common ferruginous sandstone of the hilltops) is underlaid by a singular hornstone breccia, whose adjacent angular fragments mostly fit each other, as though produced by the contraction in drying, of a gelatinous mass. The cement of this breccia is brown iron ore which fills the interstices and has colored to the depth of one-tenth to one-eighth of an inch, the substance of the hornstone fragments. (See also § 72, and note.)

These phenomena when considered in connection with the abundant occurrence of ferruginous sands and sandstones in the upper members of the group, seem to be characteristic of the *end* of the period of its formation; for no such tendency to ferrugination is observable in the overlying formations of the Bluff and Yellow Loam, whereas the principal deposits of ferruginous sandstone or pudding stone invariably occur at the *highest* levels, both geologically and hypsometrically of the Orange Sand deposits.

As to the occurrence of silicified wood, its presence in the beds of the Drift of Iowa is repeatedly mentioned by Prof. Hall; it also occurs, I believe, in the southern counties of Missouri, and in Arkansas, though not, as far as I am aware, to the extent it does in Mississippi, where in some regions, entire logs of this fossil (sometimes with part of the roots and branches) are of common occurrence. They are, however, always prostrate. I have attempted to trace to its origin the report mentioned by Prof. Wailes (First Rept. on the Geology of Miss., p. 282) of a silicified tree found standing upright with its roots in place; but it has always receded before me and vanished like a mirage. I have myself found trunks imbedded in the Orange Sand at a considerable angle with the horizon, a fact as easily explained as the discordant stratification of the formation, but which to inexperienced eyes might seem the next thing to seeing them growing there.

Yet it is hard to believe that even the violent currents and eddies, of which the irregular stratification gives evidence (see *e. g.* Pl. II, fig. 2), should have been able to transport, or elevate to the summits of the highest ridges at times, bodies of such enormous weight; even though those same agencies have doubtlessly tossed up to similar elevations the limestone fragments containing Cretaceous fossils, whose calcareous ingredients have

since been replaced by brown iron ore (§ 33). The conclusion seems inevitable that, when transported, these logs were either in a fresh, or semi-lignitized condition, such as we now find them in the subjacent lignitic strata; and that their silicification took place within the Orange Sand after its deposition. In my Report (§§ 15, 16, 44, 45,) I have given facts sufficient to prove that an abundant supply of silex has been active in this formation, which has given rise to the hard, non-fossiliferous sandstones found in it, and even to the silicification of beds of lignite *in situ* (§ 45).

That this process is still in progress seems to be proved by the disintegration, not only of hornstone pebbles (§ 32), but also of silicified wood itself; the inside of the trunks consisting frequently of translucent hornstone, while the outside is opaque, porous and sometimes (§ 44) asbestiform or pulverulent. One of the results of this process is, necessarily, the formation of siliceous solution, which in its turn may be active in effecting pseudomorphoses.

As regards the existence of the southern Drift in other southern states besides those mentioned, the subject is discussed at some length in Tuomey's second Report on the Geology of Alabama, pp. 144 to 147; elsewhere, so far as I know, it is but incidentally mentioned. He refers to the existence of a long ridge of similar accumulations parallel to the Atlantic coast, apparently upon the margin of the ancient Tertiary (Pliocene?) sea; and he identifies the detrital strata upon which the cities of Baltimore, Washington, Richmond, Petersburg, Va., and Columbia, S. C., are situated, with the Tuscaloosa beds—which in their turn, are most unequivocally connected with the Orange Sand of Mississippi. With the latter formation he was acquainted only through my verbal communications, nor was I myself, at the time, aware of the features of the formation on the large scale, or of the existence of the great delta whose apex reaches the confines of the northern Drift in Illinois and Missouri. Tuomey's doubts as to the connection between the two great divisions were therefore natural, but cannot now, I think, be sustained. Even though the waters of the northern Drift period were able to surmount, or rush through the passes of the Alleghany upheaval, they would not transport any materials beyond it; those forming the Drift of the eastern cotton states must, of necessity, be derived from the southern slopes of that barrier itself, as Tuomey states is the case in Alabama, and as I have found it to be in the eastern, and smaller, pebble belt of the Orange Sand delta in Mississippi. But where, as in the main channel of the Mississippi, those waters might rush southward unchecked, through the gap between the Alleghany and Ozark upheavals, we might expect to find traces of rocks derived from higher latitudes. Such are fur-

nished by the rare, small, and well-worn pebbles of greenstone, porphyry, trappean rocks and even mica schist, which close observation will detect among the shingle of the Mississippi-band; the direction of whose currents alone seem to forbid the derivation of these rocks from any point as far south as the eruptive and primary region of Arkansas. It remains for future comparisons, however, to settle this point.

As to the finer materials of this formation, it is significant that while the *sharpness* of the sand of the northern Drift deposits is often mentioned by writers on the subject, the sandgrains of the Orange Sand proper—that which forms the rocky hill-tops and the main body of the formation, are always very much *rounded*, as a proof of their transportation from a long distance. Whether or not the same is true of the Atlantic ridge of detritus mentioned by Tuomey, I am not aware; but it does not seem to have struck that observer.

Dr. D. D. Owen repeatedly mentions lignites and leaf-bearing clays of *quaternary* age, as underlying these deposits in Kentucky and Arkansas. Without calling in question the determination of that eminent observer, I will state that I have found no reason to suspect any more special connection between the Orange Sand and any of the lignitic beds of Mississippi, than is afforded by the obvious appropriation of the materials of the latter by the former formation—a relation existing equally where other formations underlie.

According to Mr. Lesquereux's determination, the lignitic of North Mississippi is certainly not newer than the Miocene; while some marine shells occurring in its highest strata, would seem to place it even below the lowest marine Eocene of the state (§ 162, ff.). While so far as my observations reach, I find no reason to suspect that all the lignitic strata occurring north of the marine Tertiary in Mississippi and Alabama, are not of the same age, I have nothing to urge against the occurrence of quaternary lignites elsewhere. Some of the lignitic beds of the Mississippi bluff (§ 181), of which I cannot speak from personal observation, may be of that age, as well as the small basin mentioned (§ 27) as occurring in a section of Orange Sand in Tennessee. In the absence of pretty *numerous* determinations of fossil plants, however, it must be difficult to decide upon the age of such strata, when not seen in juxtaposition with the marine Tertiary.

The Bluff, or Loess Group.—This stage of the quaternary formations does not offer, within this state, any features requiring special remark. From Vicksburg southward, it skirts the left bank of the Mississippi river, with a width, inland, of twelve to fifteen miles. It caps most of the high points visible from the

river, the maximum thickness observed being about seventy-five feet. It is usually underlaid by some member of the Orange Sand, and this in its turn by the sandstones or clays of the Grand Gulf group (§ 236 *et al.*). The chief difference between the Loess of Mississippi and that of Indiana, is the greater fineness of the material, and the total absence, as far as observed, of any but terrestrial fossils.

Apart from a few scattered sandgrains and calcareous concretions, it is a mouse-colored or buff, almost impalpable siliceous silt, but very lightly cemented by from 6 to 10 per cent of carbonate of lime. Like the Loess of Kentucky, it contains, also, a large amount (5 to 7 per cent) of carbonate of magnesia.

Helix, Helicina, Pupa and Achatina are the genera thus far found in it. As to the mammalian bones, they are here, as in Kentucky, found chiefly not in the usual material of the formation, but in a "blue clay," which, however, I have not thus far had an opportunity of examining in place. I should here state that the Mastodon bones mentioned by Tuomey as having been found in the "Drift" of the lower Tombigby and Alabama, were by himself, upon reëxamination, referred to the Bluff, and *not* to the Drift or Orange Sand age.

Above Vicksburg, the Loess deposits appear along the edge of the bluff, skirting the bottom, in irregular patches or narrow strips, such as would be exhibited below Vicksburg, were the main body of the formation, riverward, to be cut away. Such undoubtedly has been the case here, for in Tennessee, according to Safford, it is again found regularly skirting the bottom, many miles in width. It seems also that, as we advance northward, the color and fineness of the material changes, so as to resemble more and more that comprising the Loess of Indiana and Ohio.

No other river exhibits, within the state, any traces of the Loess along its course, so far as the latter is independent of the Mississippi river. The Big Black simply crosses the Loess region; the Tallahatchie and Yazoo simply touch it by accident, as it were. Neither Pearl river nor the Pascagoula, show any signs of it; while according to Tuomey, both the Tombigby and the Alabama river exhibit it characteristically, in the lower portion of their course. It would be interesting to study the circumstances which determine this apparently capricious selection. From the predominant horizontality of the lines of contact between the Orange Sand and Loess, it would seem that the deposition of the latter was not preceded by any very extensive denudations into the surface of the former; the Loess thus indicating, apparently, those channels which during the Drift period, formed the main outlets of its waters.

The Yellow Loam.—Next in the upward order, and as distinctly superimposed upon the Loess where it exists, as it is else-

where upon the Orange Sand,[1] we find a deposit consisting usually of a mellow brick clay, or loam, more or less ferruginous, and subject to inconsiderable variations in accordance with the character of the underlying materials. It might in some regions, therefore, be accounted a mere surface disintegration of older strata, but for the fact that in others it is distinctly developed as an independent stratum; its maximum thickness observed being about twenty feet, while the average lies perhaps between five and ten.

As to its geographical distribution, it is not a little remarkable that, while the preceding and succeeding stages, viz., the Bluff and the Hommock deposits, show a very obvious relation to the drainage of the country, such is the case only to a very limited extent with the Yellow Loam itself, which seems originally to have overspread the country very evenly, with on the whole a slightly increasing thickness toward the larger channels, such as the Mississippi, lower Tallahatchie, Yallabusha, Big Black, and Tombigby. The local uniformity of its material, the absence of stratification-lines in its own mass, and the horizontality of its lines of contact with underlying formations seem to be incompatible with the existence of strongly denuding currents during its deposition; while at the same time, its distribution and other characteristics render equally inadmissible the supposition of its being either a lacustrine or marine deposit.

The extensive denudations which *succeeded* its deposition render it extremely difficult to determine, in *all* cases, where this stratum is in its original place. It has disappeared, and unfortunately is still disappearing rapidly from many ridges, which according to their level as compared with adjoining regions, have been capped with it. Yet while it doubtless never was deposited upon some of the highest ridges of the state, which were above water even then, it is found manifestly *in situ* both on plateaus elevated above the general surface, and in regions a hundred or more feet lower, immediately adjoining the former. And since in all cases its character varies more or less in accordance with that of the underlying material, which enters into its composition and therefore testifies of a certain amount of denuding action, it would seem that the conditions of its deposition could be satisfied only by the assumption of the submergence of the surface under water locally deep, but always gently flowing—not sea-water, for the deposit is void of fossils—nor for the same reason, precisely such as that which deposited the Bluff formation. On the same ground, and on that of its inconsiderable thickness, we must also conclude that but a short space of time was occupied in its deposition.

[1] Or rather, upon an amorphous and ill-defined transition stratum of "hardpan," usually one to three, but locally as much as fifteen feet in thickness (§ 335).

It may be premature to attempt to define more precisely the nature of the events which attended the formation of this deposit. It may have been the result of the expiring efforts of the Drift waters to find their way over the delta, whose surface, after deeply eroding it, they had elevated by flooding it with detritus. But there is one point requiring mention as intimately connected with the subject; I refer to the peculiar constitution of the *prairies* of Mississippi and Alabama.

These differ in several essential features from the prairies either of Illinois or of the Plains. They are not usually altogether treeless, but possess a sparse growth of stout, well formed, compact Black Jack and Post Oak, with occasionally a Red Cedar; except where the Cretaceous limestone is within a foot or two of the surface, causing "Bald Prairies" with only scattered clumps of Crab Apple, Wild Plum, Persimmon, and Amorpha. Usually, the Cretaceous rock ("Rotten Limestone") is overlaid by a stratum five to twelve feet in thickness, of a material differing from the Yellow Loam of adjoining ridges only in the amount of lime and clay contained in it, and showing unequivocal transitions into the Loam stratum proper on the edge of the prairies, where on the hillsides similar material is formed, wherever the Cretaceous rock is in a corresponding position. Hence I consider the underclay of the prairies as the equivalent of the Yellow Loam, modified in its composition by the subjacent rock; just as, on broad sandy ridges, the Loam is sometimes represented by an extremely sandy "hardpan" (§ 651); or by the intractable "Hog Wallow" soil, where it is underlaid by certain stages of the lignitic Tertiary (§ 746).

As to the hypsometrical position of the Cretaceous prairies, it is not a very definite one. Locally they are surrounded by, and lower than adjoining ridges, but this is by no means the rule. Large bodies on the contrary seem rather to occupy the position of dividing plateaus, on a level, or nearly so, with the hill-tops of adjoining uplands. Their position, no less than their material, seem, therefore, to forbid attributing to them a lacustrine origin; while a comparison of the composition of the prairie underclay (§ 548) and of the Rotten Limestone (§ 149) will dispose of the idea of "surface disintegration."

There is another facies of surface conformation which seems to be parallel, not only geographically, but geologically and genetically, to the prairies, viz., the level belt of land timbered prevalently with Post Oak, and popularly known as "the Flatwoods" (§ 561, ff.). North of Ocktibbeha county, Miss., they are separated from the prairie belt by intervening ridges, but farther south the two trails coalesce, the difference of soil alone marking, in some degree, their confines. That difference is manifestly owing to, and parallel with, that between the subjacent

materials; which in the case of the flatwoods, is the heavy gray clay of the lignitic (§ 165), resisting denudation equally as much as the Rotten Limestone.

It seems to me that in this resistance to denudation is to be sought the cause, both of the absence of the Orange Sand deposits from both tracts (§ 6), and of their levelness, their surface being, as it were, parallel to that of the strata of the underlying older formation. (See profile, Pl. I, fig. 2, in Miss. Report.)

Wherever water can make little impression on the surface over which it flows, its motion is, *caeteris paribus*, more rapid, and its tendency to form deposits much less, than where a roughened bed gives rise to eddies and counter-currents, and every initial deposit induces the formation of others around it in a geometrical ratio of increase.

Whether we suppose the Orange Sand never to have been deposited on the prairies and flatwoods, or that it has subsequently been removed; its absence is to be accounted for. We cannot for a moment suppose that the waters which deposited the Orange Sand did not visit the region, since the ridges which divide the prairies and flatwoods are thickly capped with it (§§ 122, 137), and bands of Orange Sand frequently divide from each other adjacent patches of prairie land. When this is the case, although the surface may be on a level with the prairie, the Cretaceous limestone is always much deeper underground. And it is equally obvious, in passing westward from the flatwoods, that they disappear as soon as the stratum which has served to form their characteristic soil dips too low, and is overlaid by the more easily denuded materials of the lignitic (§ 587).

Considerations quite analogous to these apply also to the Tertiary prairies of South Mississippi, and the adjoining "Hog Wallow" or "Post Oak" prairie—the latter possessing no better claim to the title of prairie than the flatwoods of North Mississippi. There are but few cases in which (as in some of the prairies of Scott Co.) the subsoil can be considered a mere surface disintegration, if we confine the meaning of that term to the changes attributable to atmospheric influences alone, as should be done. Whenever the material has been transported from its original place, breaking up its structure and stratification, it must be considered a distinct deposit, no matter whether or not its chemical composition has undergone a change.

How far similar considerations may apply to the prairies of Illinois, in connection with the Carboniferous strata, those better acquainted than I am with the facts of the case must determine. It would seem to be a postulate of the ingenious theory of Mr. Lesquereux on this subject, that the Drift period should have left them greatly more level than we now find them, and if my memory serves me, the deposits of the Drift proper are but feebly represented in the level portions, the material covering the Car-

boniferous rocks being analogous, apparently, rather to the Yellow Loam of Mississippi and Alabama.

The sparseness of the timber on the prairies of Mississippi does not, as it seems to me, present any difficulty of explanation. All over the state, the Black Jack and Post Oak are the chief denizens of upland soils of extreme physical conditions; hence their prevalence on the heavy prairie soil. Owing to the luxuriant growth of grass, etc., on the prairies, but a small percentage of the most vigorous seedlings can escape the annual fires. These, however, from the fertility of the soil and the free scope for development afforded by their sparseness, can naturally become exquisite specimens of their species (§ 545).

In the "Flatwoods," *per contra*, while the species of trees selected would be the same, the exceedingly scant growth of grass would not seriously impair, in burning, the abundance of young trees. Hence we find on them a dense growth of lank, poorly clad trees, the very type of their species when occupying an illiberal soil (§ 568). Precisely the same relations, as regards their timber, existed in the uplands of the Yellow Loam region (§ 606) between the Black Jack ridges and the fertile Table-lands (611, 616), when both were regularly burnt by the Indians. The former possess a dense growth of gnarled, tattered trees, the latter had the appearance of artificial parks—now marred by the dense undergrowth which the omission of burning, or burning at the wrong season, has allowed to spring up (§ 796).

The "Hummocks," or Second Bottoms.—While the period marked by the Yellow Loam and its equivalents must have presented features not now exemplified, called forth by causes which have ceased to act, the formation next in upward order differs from those now in progress only in the quantity or intensity of the action which produced them.

The Second Bottoms form part of the valleys of all the larger streams of the state, and in some districts even of the "creeks." They are in general most extensive where the material of the adjoining uplands was most easily denuded (without being too pervious, as in the Pine Hills of the south (§§ 32, 77), and has therefore permitted the excavation of wide valleys; while, where that material resisted denudation, the contraction of the valley and consequent greater swiftness of the stream have either prevented the formation of these deposits, or caused their subsequent removal.

There are two points of difference between these "second bottoms" and the "first bottoms" of the present era, which enable the observer to distinguish them even when either is entirely absent. In the first place, the "hummock" is always out of reach of the highest water within the memory of the "oldest inhabitant," and in many cases the first bottom is as distinctly cut into the second bottom deposits, as the water channel is into the first

bottom, there being a *sudden* ascent of from three to as much as ten or more feet, while by a more gradual slope, thereafter, the difference of level often amounts to twenty feet and more. In the second place, not only is there almost always a decided difference between the materials, and consequently the soils and natural vegetation, of the first and second bottoms of one and the same stream (for example, § 809), but the nature of the latter soil shows a certain correspondence all over the state, so as to be mostly recognizable at a glance by an experienced eye. It is only in the lower portion of the course of the larger streams, that this distinction is lost in a great degree.

The soils and subsoils referred to are mostly pale gray or buff-colored, fine siliceous silts, with but little coarse sand, accompanied by *irregularly* shaped concretions of bog ore; very unretentive, and poor in phosphoric acid and lime. Their character varies measurably in accordance with the materials of the bordering uplands, whereas the first bottom soils are chiefly dependent, for their character, upon the materials into which the bed of the present stream is cut. Beneath the subsoil, we find the materials stratified precisely in the manner described by Prof. Swallow with reference to the "Bottom prairies" of Missouri, to which I have no doubt they are equivalent, as well as to the "river terraces" described years ago in this Journal (by Dr. Newberry, I believe,) from observations on the valleys of Ohio. There is but one serious point of difference as regards the former, viz., that the Bottom prairie contains the fossils of the Bluff formation, whereas the hummock deposits of Mississippi, as far as known, present but a very few and indistinct stems and leaves, occasionally, in the more clayey bands. But it must be considered, that neither is the Bluff formation itself represented on the streams in question. It therefore remains to be determined whether those fossils are an essential characteristic of the Bottom prairie, outside of the region of the Bluff formation, and on the smaller streams I have not thus far succeeded in discovering any fossils in the somewhat equivocal deposits which seem to represent the "second bottom" epoch near the mouths of the Big Black, Bayou Pierre, Homochitto and other streams, on the territory of the Bluff formation. And as to the existence of any representative of that epoch in the great Mississippi Bottom itself, I have not had any opportunity of observing.

It is evidently during the period of the Second Bottoms that the great denudations which have traced the valleys of our watercourses of the second, third, and even fourth order, were accomplished by agencies considerably more energetic than those operating at present. It was then that the sketch was made of the map whose more delicate tracery and shades the alluvial epoch has since, and is now working out. Unless we assume a somewhat *sudden* transition, a more or less *abrupt* remission of

the denuding agencies, it is difficult to understand why there should be any terraces of the kind described—why they, with their easily denuded material, should not have attained a gradual slope of surface toward the channel, instead of being as level as the first bottom itself. To my mind, the era represented by the second bottoms appears as distinctly marked as that of the Bluff formation, and as much entitled to a distinctive *name* recognized everywhere. The difficulty of the study of the quaternary formations, sufficiently great of itself, is greatly enhanced by the want of such terms, and the failure on the part of many observers, hitherto, even to attempt to parallelize in different localities the formations more recent than the Loess. If I am not greatly mistaken, the Yellow Loam, also, is as distinctly represented in Illinois and Missouri as it is south of the Ohio. Then why should not the "Loam period" and that of the "River terraces" be as distinctly recognized among American geologists as those of the Drift and Loess? Even if these divisions were not recognizable outside of the Mississippi valley, they would serve a good purpose for the study of not a small portion of the earth's surface.[1]

Since writing the above, I have received from Prof. Winchell a copy of his interesting remarks on the subject of the apparent northward transportation of large boulder deposits in the Drift of Michigan. While appreciating the force of his reasoning as regards those deposits, all my observations in this state and such portions of Alabama as I have visited, contradict the assumption of any northward transportation amongst the materials of the Drift. The steady decrease of the "grain" of transported materials as we advance southward, provided the evident direction of the transporting currents be taken into account, is an insuperable obstacle to that supposition as far as the Orange Sand is concerned. Of the "red loam" mentioned by him I cannot speak from personal knowledge, though I presume it to be identical with the material found in corresponding positions in Mississippi. If so, I cannot agree with Prof. Winchell as to its being a mere surface disintegration of the Rotten Limestone "altered *in situ* or with slight transportation." It will be seen by a glance at my map of the formations of Mississippi, that in view of the change of direction in the strike of the Cretaceous strata, the geographical position of the "red loam," supposing it to be essentially connected with the Rotten Limestone, can be accounted for equally as well by the assumption of southeasterly, as of northerly currents. That is precisely the direction indicated, as above stated, by the trend of the eastern pebble band of the Orange Sand delta.

University of Mississippi, December, 1865.

[1] The epoch here referred to as deserving a name is that designated the *Champlain*, in Dana's Mineralogy (p. 547), from deposits of the era upon the borders of Lake Champlain called the Champlain formation by Prof. C. H. Hitchcock.—Eds.

ART. XXXVIII.—*Caricography;* by Prof. C. DEWEY.

(Continued from vol. xli, p. 230, 1866.)

No. 293. *C. cephaloidea*, Dewey, Boott Illust., No. 285.

Spica composita oblonga raro sub-crassa infra foliati-bracteata, spiculis 5–10 ovatis compactis apice staminiferis interdum interruptis; fructibus *distigmaticis* ovatis oblongis in rostrum planum acute bifidum vel longi-dentatum contractis, supra convexis enervibus margine superne subalatis denticulatis lævibus, squama ovati-lanceolata vel cuspidata brevioribus vel eam subæquantibus; culmo foliaceo 2–3-pedali; foliis et spicis viridi-pallidis.

Ringwood, Ill.,—Dr. Vasey, by whom it has been liberally spread among botanists; Nebraska,—Dr. Hayden. As it grows near or among *C. sparganioides*, it may have been confounded with that species. A variety has fewer and smaller spikelets, less compacted, and grows to the height of three feet. Sometimes also there occurs nearly round-oval fruit, short rostrate on some of the spikelets, with the common form. It is distinguished from *C. sparganioides* by its long *acute* 2-*toothed* beak, and more winged and denticulate margin, and by its longer and cuspidate scale, as well as by its commonly more dense or compact spikelets.

Note.—This species in Boott is not *C. cephaloidea* Dew. in Wood's Botany, as the characters, so different, show; and it was first described in 1862 in his Illust. as above. How *C. cephaloidea* came to designate it, is unknown to me; but as Dr. Boott has fixed the name on this plant, and as no one has recognized the other, it may be well to substitute this description in Wood hereafter, giving to Dr. Boott the honor.

No. 294. *C. alopecoidea*, Tuck. Enum., p. 18, 1843.

Spica composita oblonga, spiculis 8–10 interdum pluribus ovatis subaggregatis infimis nunc subremotis superne staminiferis flavescentibus; stigmatibus 2; fructibus ovatis lanceolatis vel in rostrum mediocrem bifidum margine serrulatum acuminatis plano-convexis fere enerviis lævibus glumas ovatas mucronatas vel cuspidatas sub-æquantibus; culmo triquetro sub-2-pedali scabro basin foliato.

Found by Dr. Sartwell, Penn Yann, N. Y., and named *C. cephalophora* var. *maxima* Dew., in this Jour., vol. xliii, p. 92; in 1842, appropriately renamed by Prof. Tuckermann. It has also been discovered in Michigan by Dr. Cooley; also in Canada.

No. 295. *C. angustata*, Boott, Hooker Fl. Bor. Am. 1840.
— *stricta*, Lam. 1789.

Spicis cylindraceis tenuibus erectis 4–6; staminiferis 2–3; pistillatis 1–4 subsessilibus, superioribus apice staminiferis superne teretibus, inferioribus longioribus et infima brevi-pedunculata, inferne laxifloris distigmaticis; fructibus ovatis ellipticis subacutis brevi-rostratis vel apiculatis ore integro vix nervosis, squama arcti-oblonga subacuta varia fusca brevioribus vel eam aequantibus; culmo bipedali triquetri-acuto per-scabro foliis longis angustis rigidis glaucis margine per-scabris longiore.

Culm 1½–3 feet high, erect and stiff, very sharp and scabrous 3-sided, especially above, in large clusters or bogs, with long and recurved leaves

above bracteate; spikes 4 or 5 to 6, cylindric, rather slender for their length; staminate spikes 2–3, sessile, the lowest bracteate; pistillate spikes 1–4, commonly 2–3, upper staminate above and tapering upward and sessile, the lower longer and short-pedicellate, more loose-flowered below; stigmas 2; fruit oval or ovate, subacute, short-rostrate orifice entire, equalling or shorter than the narrow oblong acute tawny scale.

This is the *C. acuta* of Muhl. (not of Linn.), and thence of American authors for years, till Dr. Boott showed the mistake; and as they had adopted the *C. stricta*, Gooden., Dr. Boott thought it advisable to change the name given by Lamarck to that species (though the older) into *C. angustata*, as above, and continue the *C. stricta*, Gooden. Mr. Carey still retains *C. stricta* Lam., and alludes to the other species as *C. stricta* Gooden. The opinion of later botanists is that *C. angustata* is clearly distinct from the *C. stricta*, Good.

As Dr. Boott introduced the older name, *C. Magellanica*, Lam., to the exclusion of *C. irrigua*, Smith, and so long current, it is to be regretted he did not continue the work and make the change in other cases. Then *C. tenella*, Ehrht. would have banished *C. tenella*, Schk., even though Schk. himself had not already expunged it, as a synonym of *C. loliacea*, Linn.: so of some others.

No. 296. *C. juncea*, Willd., Syst. Veg. 1826.
— *miser*, Buckley;[1] Sill. xlviii, 141, 1845, and xxix, 346, 1860.

Terminal spike staminate, short-cylindric, with scales oblong and obtuse; pistillate spikes 2, rarely 3, slender, subremote, loose and alternate flowered, pedunculate, long and setaceous-bracteate; stigmas 3; fruit slender, lanceolate, subtriquetrous, scabrous above, longer than the ovate obtuse white-edged scale; culm a foot or more, slender, longer than the radical narrow leaves; plant light green.

Boston or vicinity, very rare, doubtless introduced from Europe.

No. 297. *C. rotundata*, Wahl. 1803.
— *globularis*, Schk., No. 111, fig. 93.

Terminal spike staminate, linear, erect, with tawny linear and obtuse scales; pistillate spike one, rarely two, cylindric, sessile, distant exsertly leafy-bracteate, densely flowered; stigmas 3; fruit ovate, subglobose, rather obtuse apiculate or short-rostrate, smooth, about equal to the ovate obtuse scale; culm short, erect, longer than the narrow subulate roughish leaves.

Arctic regions, Dr. Richardson. These brief characters may help some of our botanists in discriminating this species. In my Lapland specimen, said to be from Wahlenberg, the fruit may be too young for the figure of Schk., as the fruit is scarcely globular.

No. 298. *C. extensa*, Gooden., Schk., p. 56, No. 62.

Terminal spike staminate cylindric, an inch long, with oblong obtuse or sub-acute reddish-brown scales, rarely a short small staminate one below and near; pistillate spikes 1–4, often two, round oval short sessile and approximate, or one of them longer and cylindric, sometimes 3 or 4 cylindric except the upper one near the terminal staminate at the sum-

[1] For his description see this Journal, xlv, 1843.

mit, sometimes 2 near the staminate and a third remote cylindric, rarely quite long exsertly-pedunculate, all leafy-bracteate and the lower bract sheathing while the leafy bract equals or surpasses the culm; stigmas 3; fruit ovate or oval, tapering below and acutely above into a bidentate short beak, nerved and nearly twice longer than the ovate short-mucronate scale; culm erect, smooth, triquetrous, leafy toward the base; leaves narrow, long, scabrous above on the edges and about the length of the culm; plant pale green.

Common along salt marshes in England, France, Sweden, &c., and in our country in similar position at Coney Island and on Long Island, where it was found several years ago, and since very abundantly, by Dr. T. J. Allen. On some specimens from France are four pistillate spikes and two staminate spikes nearly an inch long, and similar to this on the German specimens: some from Coney Island have two staminate spikes. The figures in Schk. are too defective to be useful. My specimens come through the politeness of J. A. Paine, Jr., the discriminating author of the Catalogue of Plants from Oneida Co., &c.

C. lupulina, Muh., vol. xi, p. 165, this Journal, 1826.
var. *gigantoidea*, Dew.

Staminate spikes 1–3, often 2–3, sometimes 1 with stamens on one or two of the upper pistillate spikes, cylindric, erect and covered with long and large lanceolate scales, the upper quite long and the lower shorter and near; pistillate spikes 2–3, cylindric or oblong, large and thick, densely flowered, the lower short pedunculate; fruit ovate-lanceolate, more ventricose than the common plant, or slightly ovate-globose, and more like that of *C. gigantea*. The achenium or seed very different from that of *C. gigantea*, and not like that of the common *C. lupulina*, which is too nodose in fig. 162, and too little nodose in fig. 279 on p. 95, No. 232.

The following differences need consideration, which are very obvious, as *C. lupulina* and this so named variety grow together and are abundant. The former rarely has more than one staminate spike, the latter very rarely has so few as *one*, and often three.

Of the former the fruit is very long and nearly erect; and of the latter smaller and somewhat shorter, as well as horizontal or even reflexed at the base.

The spikes of the latter have less diameter, or about two-thirds the size of the former.

The seed of the latter is mature early in August; that of the former is ripe late in September on the same ground; and on the late maturing latter plant the seed is not developed beyond its small beginning, and will be abortive.

The achenia of the two are unlike; that of the former is triquetrous, with nodose projections on the middle of the three edges, and quite tapering 3-sided above and below; that of the latter is not thus knotted, and is shorter and less tapering or somewhat round-edged above.

The spikes of the former were green on the middle of September; at that time those of the latter were brown or straw color, or quite mature.

The former is not so tall as the latter more slender plant.

The latter grows in well defined tufts or clusters; the former in single or few detached plants and not in tufts; the difference is obvious and striking.

The divergence of the fruit resembles *C. retrorsa* more than *C. lupulina*, yet the achenia are very different.

These differences are too marked for the same species; but for the present, and until connecting forms fail to be discovered, it may be wise to call it var. *gigantoidea*.

Near Cayuga Lake, Ludlowville, Tompkins Co.,—H. B. Lord, Esq., who has pointed out most of the above differences. He stated also that Dr. Gray, as well as myself, thought the plant a form of *C. gigantea* at the first.

C. gigantea, first described by Rudge in the Transactions of the Linn. Soc., 1803, was credited to Carolina. It has been found growing in Louisiana, and northward as far as Kentucky and Delaware. From the last state it was sent me a few years ago and also this year, by Wm. M. Canby, Esq. It is a southern plant, and finely shown in Boott.

The first *C. lupulina* that I saw with two staminate spikes, was received many years ago from Dr. Short, of Louisville, Ky. I hoped it was *C. gigantea*, but it proved a real *C. lupulina*.

Note 1.—Discoveries have made more full descriptions of some species desirable. Only a few can be given.

C. filifolia, Nutt., vol. xi, 1826, and vol. xii, 1827, of this Journal. Illust., No. 36, fig. 37, Boott.
Uncinia breviseta, Torr. Mon., p. 428.

Spike single, staminate above, cylindric or tapering, with broad close and obtuse scales, brown and white edged, pistillate at the base and also much larger by the three to six or eight fruit; stigmas three; fruit ovate-triquetrous, rather obovate in maturity, tapering below, 1–4 on the small form and 3–8 on the taller, short-apiculate, about equalling the short very broad and often very obtuse or even retuse scale, which is white hyaline when the fruit is mature and brown with white edges when young; culm 3–4 inches, or 6–8 inches, clustered, with involute filiform leaves often nearly as long as the culm.

Plains of Missouri,—Nuttall, 1818, "cespitose, scarcely a hand breadth high;" Arctic America and widely on the Rocky Mountains,—Richardson & Hall; Fort Pierre, Nebraska,—F. V. Hayden, 1855: the taller on the Rocky Mountains.

C. livida, Willd. Wood's and Gray's Bot.
— *limosa* var. *livida*, Wahl. in this Journal, vol. x, p. 41, 1826, credited to Becket, Mass.
var. *radicalis*, Paine.

This curious variety has a pistillate spike on a long radical peduncle from the same root, with a leafy culm bearing a terminal staminate spike, the peduncle nearly as long as the culm.

Cold marshes, Litchfield, Herkimer Co., N. Y., with the typical form,—Paine, in his excellent "Plants of Oneida County and vicinity," now (1865) being printed; also, in Manchester, N. J.,—Knieskern.

This is very like that described in this Journal, vol. xxxix, p. 71, 1865,

from the same section of the state, which sometimes has a pistillate spike contiguous to the staminate on the leaf-bearing culm.

Of *C. irrigua*, Sm., vol. x, p. 42, now *C. Magellanica*, Lam., vol. xxxix, 1865, is found a form approximating toward that of the preceding anomalies, viz., nearly, but not quite, radical long peduncles bearing a single pistillate spike. Swamp near Rome,—Paine.

C. pubescens, Muh., so regular in its form, occasionally has a long, nearly radical, peduncle and spike, far from the usual place of the lowest pistillate. Mr. Paine.

C. Sartwelli, Dew., vol. xliii, p. 90, 1842, is found to be a variety of *C. intermedia*, Gooden. in Schk. (the *C. multiformis*, Thuillier), which was afterwards seen to be a form of the earlier named *C. disticha*, Huds., in Fl. Ang.; but all these, sometimes in one locality, are found growing in the states of New York, Illinois, Wisconsin, Canada West and other British possessions. The designations should have the following order:

C. disticha, Huds., substituted for the later synonym,
— *intermedia*, Gooden., vol. iv, p. 343, 1847;
var. *Sartwellii*, Dew., in place of this named species above.

And the only needed additions to the description of *C. intermedia* as *C. disticha*, are the often recurring *two-rowed form* of the *spikelets*, which diminishes with the stamens till both disappear frequently in a regular spike of only pistilliferous spikelets. Specimens precisely like the varying forms of *C. Sartwellii*, have come to me from the north of Europe.

C. muricata var. *cephaloidea*, Dew., this Journal, vol. xi, p. 308, 1826, is *C. sparganioides*, Muhl., var. *minor*, Boott, Illust., No. 284, and first published in 1862 by him.

C. miliaris, Mx., vol. x, p. 36, 1826 this Journal. The description according to that of Michaux was given to aid botanists in detecting the plant; but near thirty years have passed, and this is the only species of the Carices of Michaux which has not been ascertained satisfactorily. Dr. Boott obtained figures of it taken from Michaux's herbarium at Paris, and learned that it has two stigmas and a staminate spike with *narrow linear* scales. I also have a figure of the same, taken at Paris and sent to Dr. Torrey, who long since politely made me a present of it. All the figures are very much alike, and indicate the plant to have an erect slender culm, with stiff, very narrow and not very long leaves, at most are all shorter than the culm. On my figure the stigmas are not given, but the fruit agrees with Michaux's language, with a scale ovate-oblong, obtusish, and rather longer than the fruit. His friend also wrote to Dr. Boott that he found the "curious character" of *glands* or *glandular hairs* covering the upper part of the fruit to the vertex, which *disappeared on the mature fruit*, or was displaced or removed by friction. Such is the amount of present knowledge of *C. miliaris*, Mx. Dr. Boott thinks, it will be found to be, when discovered, "inseparable from *C. saxatilis*, L. (*C. pulla*, Good.). Illust., No. 187.

This may be hoped. On the specimens of *C. saxatilis*, L., the scales of the staminate spike are oblong and not narrow linear; the fruit is longer than its scale; and the leaves are broader than the figures represent, and also more flexible.

C. stenolepis, Torrey, this Journal, xxx, 59, 1836.

Some addition to the description given in the Journal, on specimens sent me by Dr. Torrey, is required. For Dr. Torrey soon found in a large number of specimens that many have not the terminal spike wholly staminate, but pistillate above, some of which spikes were not half staminate; in some the staminate spike is very small or merely rudimentary, and the pistillate spikes "smaller and shorter, so as to be ovate or subglobose." Similar differences occur in the specimens from Texas as well as Kentucky. Torr. Mon., p. 421–2.

C. adusta, Boott, var. *minor*, Boott, Fl. Bor. Am. 1840, is held by him to include *C. argyrantha*, Tuck., which some still doubt.

C. Vaseyi, Dew., this Journal, xxix, 347, 1860.

In his Illust., No. 71, Dr. Boott gave the difference between this plant and both *C. vesicaria* L. and *C. monila* Tuckerman; and hence it was named as above. Yet I have been led to enquire, if the not mature form, *C. Vaseyi*, from Dr. Sartwell, may not be an immature state of *C. monila*. Both Prof. Tuckerman and Dr. Boott have decided to the contrary. Another season may give satisfactory conclusions to all.

C. cylindrica, Schw., from more extended comparisons of discovered species, appears to belong to the small form of *C. utriculata*, Boott, and to be *C. utriculata*, var. *minor*, Boott, in his Illust., No. 37.

Note 2.—In the midst of ill health I have completed this forty-first article in the series on Carices, which was begun in this Journal, vol. vii, 1824, and which has been continued at intervals to the forty-second year, an extent and period wholly unanticipated. Encouraged by the honored and successful and lamented first editor, and favored by his learned successors, I am happy to express my obligations, and to record my gratitude and respect. Should health be given, I may perhaps prepare the often-solicited catalogue of all the species, a natural and fitting termination of this Caricography.

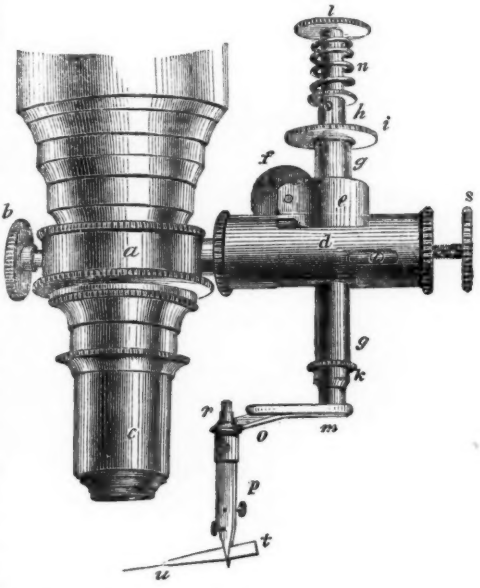
Art. XL.—*On a Mechanical Finger for use with the Microscope;* by H. L. Smith, Kenyon College.

In order to make out satisfactorily the structure of the Diatomaceous frustule, viewed as an opaque object, I found it necessary to be able to change its position while still in view; and for this purpose, to mount it upon the end of a fine bristle, or hair. The bristle, having the diatom frustule adhering, may be placed in one of Mr. Beck's revolving slide holders for opaque objects, and examined with comparative ease on several sides. To pick up the diatom upon the end of the hair, or bristle, I contrived the little piece of apparatus which, perhaps, may not inappropriately be named "a mechanical finger," and which

is figured in the accompanying wood-cut. I find it answers most admirably to pick out diatoms and, of course, other minute objects, from a mass of accompanying dirt or debris, and transfer them to a clean slide. Thus from a sample of the "Bermuda deposit" the finer forms of Heliopelta may be rapidly picked up and placed together on one slide, the Eupodiscus *Rogersii* on another; Craspedodiscus *elegans* on another; and in like manner, the various species of Coscinodiscus and Aulacodiscus. These being all mounted after the method presently to be described, in the center of the usual glass slide, present great facilities for ready reference, and appear much more beautiful than when mixed with a lot of foreign material. The precision with which even very minute diatoms may be picked up and transferred constitutes the chief value of this little instrument. It is not, indeed, so very difficult for an experienced microscopist, who has become accustomed to the reversed motion of the hand when using the compound microscope, to pick out with tolerable ease the larger diatoms by means of a hair mounted in a suitable handle, but if the specimen is a very fine or rare one, he is exceedingly liable, through over nervousness, to injure or lose it; and, if very small, to fail entirely. The mechanical finger is entirely free from this nervous excitement, and the hair touches gently, and with the utmost precision, the indicated diatom or other object, and holds it until the receiving slide is made ready, then drops it just where it is desired. By far the greater number of those working with the microscope will, however, be found entirely unable to pick out and transfer specimens by the unaided hand, and to this class the present invention will, no doubt, be acceptable.

The cut represents the instrument attached to the lower or objective end of the microscope. An adapter, having the "Society screw" outside and inside, is screwed into the nose piece of the microscope, and upon this adapter the ring *a* moves freely between two collars and may be clamped, by means of the milled-head screw *b*, in such position as may be deemed best for use. Into the lower part of the adapter an objective (*c*) is screwed; the $\frac{2}{3}$d-inch will answer very well, using the B eyepiece. A tubular arm (*d*) is screwed to the ring, opposite to the clamping screw *b*, and inside of this arm moves another tube carrying the piece *e*, which is a circular clamp tightened by means of the milled head *f*; the whole is moved to or from the microscope body by means of the screw *s*, which pushes against a stout spiral spring. Within the clamp *e*, the smaller tube *g* moves up and down, parallel to the body of the microscope, and may be clamped in the proper position by means of the screw *f*. Inside of the tube *g* is fitted neatly another tube *h*, having the large milled flange *i* firmly attached above, and the smaller

one *k* screwed on to it below. This tube can be turned around freely in the tube *gg* by means of the milled flange *i*, but it has no motion up or down. Within the last mentioned tube the rod *n m* moves smoothly up and down a limited amount, determined by the slot and guide pin, as shown near *h*. A milled-head (*l*) receives the finger when it is desired to depress the rod, and, on releasing the pressure, the spiral spring *n* instantly elevates it. To the lower end of the rod the flat double-jointed arm *m o* is attached, having free lateral movement; the end of the arm carries the small spring forceps *p*, which turns freely in the socket *r*. The forceps grasp the triangular slip of card *t*, which has a bit of human hair *u*, gummed to it, and projecting about $\frac{1}{10}$th of an inch.



The slips of paper and the size and length of the hair may be varied to suit the different objects which are to be picked up. To use the instrument the following adjustments are necessary. We will suppose the $\frac{2}{3}$-inch objective is employed. The ring *a* is first firmly clamped, and the slip of card bearing the hair is put in the forceps *p*, inclined downward as represented in the cut, but not too much; the tube *g* is elevated in the clamp *e*, and, by means of the milled head *i*, the arm with forceps and hair turned one side. For my own use I prefer to clamp the ring *a* in such position as to place the tube *d* at the left hand of the microscope, using one of the fingers of the left hand to depress the head *l*, the right hand being free to use with the mechanical stage, and for focussing. Place on the stage a slide with a bit of thin paper pasted near its centre, and having a small cross marked on it, or a simple black dot. Next, bring this dot into focus, and, while thus remaining, turn back the

tubes *g* and *h* by means of the head *i*, and so adjust by slipping the tube *g* up and down, and by moving the arm *m o*, or the forceps *p*, in the socket *r*, that the end of the hair shall stand just over and a *trifle above* the dot; now clamp *g* by means of the screw *f*; and bring the point of the hair so that it may be seen, slightly out of focus, when looking into the microscope, just over the intersection of the cross, or the dot, by means of the screw *s*. The whole may now be elevated by means of the rack of the microscope and the adjusting slide replaced by another containing the material from which it is desired to pick up certain objects. If the material is dried upon mica from a suspension in alcohol, the object may be picked up easily; if dried upon glass, from suspension in water, it sometimes adheres strongly, but with a little care is easily detached. If the illumination from below is too strong, the hair, which is, of course, a little within the proper focus, is not so readily seen at the same time with the object as it is with a feebler illumination. Upon depressing the tube of the microscope the forceps and hair are likewise depressed, and when the desired objects are in focus the hair will be dimly seen, projecting into the field of view. The object being now brought under the point of the hair, by means of the stage movement, the hair is pushed down gently by means of the finger applied at *l*, its tip just touching the object. If the hair is too much within the focus it may first be slightly depressed, yet not so as to touch the object, and then, by means of the stage movement, the object can be placed distinctly under the point. Sometimes the first touch will lift the object, but generally it will take two or three touches to dislodge it. When it rises with the hair upon releasing the pressure, the whole is to be gently elevated by means of the rack of the microscope, so that the slide can be removed without disturbing the hair. In doing this care must be taken to avoid a current of air, made by the breath, or quick movement of the hand, as this might dislodge the object. In order to place the objects quickly at just the right place on a clean slide, I cut a small hole in the center of a gummed label and stick it on to the slide, so that the hole is exactly in the center. This may be done rapidly, by previously marking the outline of the slide on a paper and placing a dot at the center. The perforated label is supposed to be on the under part of the glass slide. Upon breathing heavily upon the upper surface of the slide, a copious deposit of moisture is effected, and the slide is then to be immediately placed on the stage, and its central portion, indicated by the hole in the gummed label, brought to the center. If an achromatic condensor is used this is easily done, as the spot of light will show itself shining through the paper. The tube of the microscope is now depressed, of course carrying the hair and the object

with it, until the moisture is in focus; a slight touch of the finger now causes the hair to descend, and instantly the moisture takes the object off and causes it to lie flat on the glass. Of course the slide, having the objects thus placed upon it, must be handled gently; but there is no danger of disturbing or losing the objects if it is first gently breathed upon, but not obliquely unless with great care. The next step is to mount the objects, of which we will suppose there are several, say of *Stauroneis acuta*, in the center of the slide, without displacing them and altogether making but a slight white spot when viewed without a magnifier, or by a lens of one or two inches focus. Cut a small circular disc or square of thin glass of about a quarter of an inch in diameter or breadth, and warming it gently, after cleansing it, place at one edge a minute drop of Canada balsam, not too old, nor yet too fluid. Warm the slide gently to drive off all moisture, but not hot enough to cause the balsam to flow when the little cover is put on, yet sufficiently warm to make it stick. The cover being lodged over the objects, but not touching them, as it is held off by the little drop of balsam, the next step is to warm the slide at one end very gently; the heat conducted along the slide soon causes the drop of balsam to spread and move forward under the slide. Care must be taken not to do this too rapidly. If heated slowly the balsam will move forward and the cover settle down without disturbing at all the positions of the objects, and seldom requiring any reheating. The balsam should be hard enough to fix the cover firmly, and all pressure upon it carefully avoided when the slide is entirely cooled.

To finish the slide, all that is necessary is to paste another label, with a small hole in its center, directly over the glass cover, and coinciding with the hole below; or if preferred the under label may be removed, leaving only the small round disc on top to cover the object. I prefer the perforated paper above and not below, as it indicates readily the exact spot occupied by the objects, and protects the covering glass from accidental dislodgement, and the slides thus finished appear quite neat if the gummed labels are properly selected.

The instrument as described above was made for me by Wales & Co., Fort Lee, New Jersey, and is a very fine specimen of their skill in the nicer forms of mechanical work. It is but justice to them to attribute much of the success of this contrivance, to the very careful manner in which they have made it.

The hair should move nicely up and down when magnified by the microscope, and touch the desired object with precision; for this purpose the rod *n* must move very smoothly, and all lateral motion of it prevented by the careful arrangement of the pin and slot, as shown near *h*. If, after the object is mounted

on the clean side, it is desirable to examine it with a higher power, say a $\frac{4}{10}$th- or $\frac{1}{5}$th-inch objective, it is not necessary to remove the hair from the forceps; the whole may be turned one side without disturbing the arrangements, by means of the milled collar *i*, and the lower objective being removed, a higher may be substituted; upon again replacing the first objective, and turning back the head *i*, the hair will again appear in the right place for use.

It will frequently happen that the hair will gather up considerable dirt and must be cleansed; this is readily done by slightly scraping it, without removing from the forceps, by the edge of a sharp, clean knife. The little spring of the hair as the knife edge slips off the end, will readily throw off all the loosened dirt. If too much dirt is picked up with the diatom, or other object, it may first be deposited upon a cleaner place of the slide, and again picked up freed from most if not all the foreign material.

One great advantage of this little instrument is, that it enables us to turn over a diatom, or deposit it on end, and thus obtain views very difficult to be had from balsam mounted specimens; and again, the frustules viewed dry often present particulars with great distinctness that can only be glimpsed, or guessed at, when mounted in balsam, and for this purpose it is very necessary to have them mounted on a clean slide, and themselves free from dirt. If the diatoms stick too firmly to be raised by the hair, they can generally be loosened by strongly heating the slide, and on this account I prefer mica to receive the material from which the selections are to be made.

I have been more particular in describing this instrument, as some who have procured the reflector for opaque illumination,[1] did not succeed well in using it until after many trials and disappointments. I have, however, received testimony from many of the most experienced workers with the microscope in this country as to its complete success, and trust the "mechanical finger" will be duly appreciated, and prove fully capable of doing all I have claimed for it.

Since the preceding article was written a further experience in using the mechanical finger enables me to add a few useful suggestions. It will happen frequently that specimens having considerable thickness, e. g. Triceratium *favus*, or some very fine specimen of Actinoptychus may be picked out; these, if mounted under a small bit of thin glass, will probably be crushed, and entirely ruined; and especially if the label punctured with a small hole is pasted over the glass cover, to indicate the exact locality of the object. In a case of this kind, the injury may be

[1] See this Journal, Sept. 1865.

prevented by inserting a small bit of tissue paper under the glass cover, to keep it from pressing the object, when the balsam runs under. If the alcoholic solution containing the diatoms should deposit any resinous or gummy matter, on drying, the diatoms will stick fast to the glass; excessive heating will be of no avail to dislodge them, and may be injurious. To meet this difficulty breathe gently, but sufficiently long to deposit considerable moisture, on the slide, without removing it from the stage, and immediately bring the hair in contact with the object; it will now be loosened, and if kept moving, by pushing it on the slide until the moisture has evaporated it can be picked up. I have found that the outside bristle of an ordinary clothes brush has generally a nice point worn upon it, if the brush has been long used; it is somewhat stiffer than the hair and may therefore project farther beyond the paper to which it is gummed. With care the diatoms may be so located that they will be in the exact center of the slide, and thus, when the microscope is adjusted for one, the others, although on different slips of glass, will be in the field with a high power, and this even when the ends of the slide are reversed. It is best to thoroughly explore the slide before picking up the objects, and to register those desired to be preserved. In this way the choicer specimens can be selected, and the whole slide completely examined.

ART. XLI.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

[Concluded from p. 192.]

A COMPARISON of the carefully prepared lists of Greenland birds by Reinhardt in the Ibis for 1861, and of Iceland birds by Newton, published in "Iceland, its Scenes and Sagas," by Sabine Baring-Gould, in 1863, will show that all the land birds mentioned as abundant in Iceland are, with few exceptions, more or less common in Greenland; and it is therefore very probable that the additions to the lists of European birds found in Greenland are to be looked for among the remainder of the Icelandic species. The following list, compiled from the above sources, of all land birds of Iceland and of the European species occurring in Greenland, will illustrate the relationship in this respect.

European land birds found in Iceland and Greenland.

	Iceland.	*Greenland.*	*North America.*
Haliætus albicilla (Linn),	Common.	Very common.	? Very rare.
Falco Canadensis, Gmel.,	Rather rare.	Common.	Quite common.
" Islandicus, "	Very common.	Rare.	Rare.
" peregrinus, L.	Problematical.	Not common.	Very rare.
" æsalon, L.	Very common.		
Nyctea nivea, H.	Rather rare.	Very common.	Very common.
Otus brachyotus,	Rare.	Very rare.	" "
" vulgaris,	One specimen.		
Chelidon urbica (Linn.),	Rare.		
Hirundo rustica, L.	"		
Troglodytes borealis, Fischer,	"		
Turdus merula, L.	Seen twice.	[killed.	
" iliacus, L.	Common.	Two specimens	
" pilaris, L.	Doubtful.		
Ruticilla tithys (Scop.).	Seen once.		
Saxicola œnanthe, Linn.	Common.	Common.	Rare.
Motacilla alba, L.	"	Two specimens.	
Anthus pratensis,	"	One specimen.	
Plectrophanes Lapponica, L.	Very rare.	Common.	Very common.
" nivalis, L.	Very common.	Very common.	" "
Aegiothus linaria, L.	Rare.	Common.	Common.
" canescens, Gld.		"	
Sturnus vulgaris, L.	Rare.	One specimen.	
Corvus corax, L.	Common.		
" cornix, L.	Rare.		
Lagopus Islandorum, Fabr.	Common.	Common.	Common.

From an examination of the above list it will be seen that the only land bird abundant in Iceland and not noticed in Greenland is *Falco æsalon*. The European species to be looked for in Greenland as occurring in Iceland are only the *F. æsalon*, *Chelidon urbica*, *Hirundo rustica*, *Troglodytes borealis*, *Turdus merula*, *Ruticilla tithys*, *Corvus corax?*, and *Corvus cornix*. It will also be noticed that all the European land birds common in Greenland have also been found in continental North America.[1] The Ptarmigans of the three regions will quite probably be found identical.

The following is a table of the water birds of Greenland and Iceland belonging to the European fauna, from which it will be seen that two species, *Crex pratensis* and *Ortygometra porzana*, are found in Greenland and are not yet recorded from Iceland; eleven or twelve species in Iceland and not in Greenland; one in Newfoundland, *Scolopax rusticola*, and neither in Greenland or in Iceland; eleven in both Greenland and Iceland. There are in Greenland proportionally fewer water birds than land birds of the European fauna that occur in continental North America.

[1] *Haliætus albicilla* was noticed by Sclater as found in Newfoundland and Nova Scotia; although now he considers the evidence rather uncertain. The Smithsonian Institution possesses specimens of true *Falco peregrinus* as distinguished from *anatum* from Moose Factory, Hudson's Bay.

	Iceland.	*Greenland.*	*North America.*
Vanellus cristatus (Meyer),	Occasional.	Two specimens.	
Charadrius hiaticula (L.),	Not rare.	Not rare.	
" pluvialis (L.),	Very common.		
Hæmatopus ostralegus (L.),	Common.	Three specimens.	
Ardea cinerea (L.),	Occasional.	Two specimens.	
Falcinellus igneus,	Very rare.		
Numenius phæopus (L.),	Very common.	Not rare.	
" arquatus (Linn.),	Rare.		
Philomachus pugnax (L.),	One specimen.		Several specimens.
Limosa ægocephala (L.),	Common.	One specimen.	
Gallinago media (Leach),	"	Common.	Bermuda.
Scolopax rusticola (L.),			Newfoundland.
Fulica atra (L.),	Rare.		
Crex pratensis (Bechst.),		Very rare.	Occasional.
Ortygometra porzana (L.),		"	
Rallus aquaticus (L.),	Rare.		
Bernicla leucopsis (Temm.),	Common.	Common.?	Doubtful.
Anser ferus (L.),	Rare.		
" segetum (Bechst.),	Rare.		
" brachyrhynchus (Baill.),	Rare.		
Cygnus ferus (Leach),	Common.	Not rare.	
Nettion crecca (L.),	Very common.	Common.	Not rare.
Mareca penelope (L.),	Quite common.	Not rare.	"
Querquedula querquedula (L.),	Problematical.		
Fuligula ferina (L.),	One specimen.		
Oidemia nigra (L.),	Rare.		
Larus canus (L.),	Very rare.		

The following list embraces the strictly North American birds which are recorded by Reinhardt as occurring in Greenland.

Falco candicans.
Hirundo horreorum.
Cistothorus palustris.
Regulus calendula.
Dendroica coronata.
" virens.
" striata.
Parula Americana.
Helminthophaga ruficapilla.
Geothlypis Philadelphia.
Anthus Ludovicianus (breeds).
Turdus minor.[2]
Tyrannula pusilla.[3]
Contopus borealis.
Vireo olivaceus.
Xanthocephalus icterocephalus.
Zonotrichia leucophrys.[4]
Loxia leucoptera.
Eremophila cornuta.?
Sphyropicus varius.
Colaptes auratus.
Charadrius Virginicus.
Numenius Hudsonicus.
" borealis.
Actodromas maculata.
Gambetta flavipes.
Macrorhamphus griseus.
Porzana Carolina.
Fulica Americana.
Nettion Carolinensis.
Bucephala albeola.
Pelionetta perspicillata.
Podiceps Holbölli.
Rhodostethia rosea.
Xema Sabini.

While therefore it appears that Iceland in all probability furnishes a considerable number of species of European birds to Greenland, the latter supplies very few American birds in return. This is owing to the fact that Iceland lies east of the southwestern extremity of Greenland, and in part south of its

[2] It is difficult to say which of the three allied species of North American thrush is meant here.
[3] This species is also indeterminable.
[4] Quite as likely to be *Z. Gambelii*.

eastern coast, so that the visitors from the continent of North America in their northward or northeastern movement and corresponding return would not come near Iceland at all, while on the other hand a migration to the north and northwest from Iceland would necessarily soon strike Greenland at a distance of only a few hundred miles, especially aided by the prevalent aerial currents, of which mention will be made hereafter. The following are the only peculiarly North American or Greenland species noted in Mr. Newton's list: *Falco candicans* Gmel., *Numenius Hudsonicus* Lath., *Histrionicus torquatus* Bon.

It is difficult to say whether the Iceland Golden Eye (*Clangula Islandica*) is a gift from Iceland to Greenland and North America, or *vice versa*. While abundant in Iceland, it is by no means rare in North America, being some years quite common as far south as the St. Croix river.

The British island of Heligoland in the North Sea, off the coast of Denmark, is of special interest in an ornithological point of view, from its furnishing more species of European birds than any other locality of its extent (400 out of about 500 species admitted by Blasius), as well as several Asiatic and North American species not recorded as having occurred elsewhere in Europe. To the labors of Herr Gätke, a resident of the island, extended over more than twenty years, we are indebted for the curious and remarkable facts referred to (Naumannia, 1858, 419). The North American birds observed by him are—

Anthus Ludovicianus,	Nov. 6, 1851.	Tryngites rufescens,	May 9, 1847.
Dendroica virens,	Oct. 19, 1858.	Pelionetta perspicillata,	Oct. 9, 1851.
Harporhynchus rufus,	Oct. —, 1857.	Xema Sabinii,	Oct. 25, 1847.
Galeoscoptes Carolinensis,	Oct. 28, 1840.	Rhodostethia rosea,	Feb. 5, 1858.
Charadrius Virginicus,	Dec. 20, 1847.		

The following North American birds are recorded in Prof. Blasius's "List of the Birds of Europe, 1862," edited by Newton, in the British Museum Catalogue of British birds, and in other authorities, as occurring in Europe:—

Falco candicans,		? Lanius excubitoroides,	(England.)
Nauclerus furcatus,	(England.)	Turdus Pallasii,	(Germany.)
Nyctale Acadica,	"	" Swainsoni,	(Belgium; Italy.)
Scops asio,	"	" migratorius,	(Germany.)
Colaptes auratus,	"	Anthus Ludovicianus,	(Heligoland.)
Picus villosus,	"	Vireo olivaceus,[5]	(Chillaston, near Derby, Eng., May, 1859.)
" pubescens,	"	Regulus Calendula,	(England.)
Coccygus Americanus,	"	Ampelis cedrorum,	"
" erythrophthalmus,	(Lucca.)	Loxia Americana.	
Ceryle alcyon,	(Ireland.)	" leucoptera,	"
Progne purpurea,	(England.)	? Aegiothus canescens,	(Belgium.)
Hirundo bicolor,	"	Spiza ciris,	(England; cage bird?)
Dendroica virens,	(Heligoland.)	Agelæus phœniceus,[6]	(England.)
Harporhynchus rufus,	"		
Galescoptes Carolinensis,	"		

[5] Ibis, 1864, 394.

[6] Ibis, 1861, 177.

Sturnella magna, (England; March and October.)
Ectopistes migratoria, (England.)
Charadrius Virginicus, (Heligoland.)
" vociferus, (England.)
Gambetta flavipes, "
Symphemia semipalmata, (Sweden.)
Actiturus Bartramius, (Germany; England.)
Tringoides macularius, (Eng.; Germ.)
Tryngites rufescens, (Eng.; Heligoland.)
Macrorhamphus griseus, (England.)
Actodromas maculata, "
" minutilla, "
" Bonapartii, (England; France.)
Numenius Hudsonicus, (Iceland.)
" borealis, (Scotland.)
Porphyrio martinica, (England.)
Porzana Carolina, (England: Newbury, Oct. 1864; Zoologist, 9540.)
Botaurus lentiginosus, (England.)
Nycticorax violaceus, "
Anser hyperboreus, (Germany.)
Bernicla Canadensis, (England.)
Querquedula discors, (Northern France.)
Mareca Americana, (England.)
Cygnus Americanus, "
Fulix affinis, "
" collaris, "
Bucephala albeola, "
Pelionetta perspicillata, (Heligoland.)
Lophodytes cucullatus, (England.)
Plotus anhinga, "
Tachypetes aquilus, (Weser.)
Sterna fuliginosa, (Engl.; Magdeburg)
Anous stolida, (England; France.)
Rhodostethia rosea, (Heligoland; England.)
Xema Sabini, (Heligoland; England.)
Chroicocephalus atricilla, (England.)
" Philadelphia, (Ireland.)
Oceanites oceanica, (England.)
Puffinus fuliginosus, (France; England.)
" obscurus, (England.)
Podiceps Holbölli, (Holland.)

Of the 69 species of the above list, all but 19 occurred in Great Britain and Ireland.

List of birds supposed to be identical in Europe and North America, or not satisfactorily separated.

Archibuteo lagopus.
Aquila chrysætos.
Pandion haliætus.
Brachiotus vulgaris.
Nyctea nivea.
Surnia ulula.
Cotyle riparia.
Ampelis garrulus.
? Pinicola enucleator.
Aegiothus linaria.
Plectrophanes Lapponicus.
" nivalis.
? Corvus corax.
? Lagopus albus.
? " mutus.
Squatarola Helvetica.
Strepsilas interpres.
Phalaropus hyperboreus.
" fulicarius.
Tringa canutus.
" maritima.
" subarquata.
Calidris arenaria.
Bernicla brenta.
Anas boschas.
Dafila acuta.
Spatula clypeata.
Chaulelasmus streperus.
Fulix marila.
Histrionicus torquatus.
Bucephala clangula.
" Islandica.
Harelda glacialis.
Polysticta Stelleri.
Somateria mollissima.?
" spectabilis?
Mergus serrator.
Sula bassana.
Graculus carbo.
Stercorarius (all species).
Larus glaucus.
" leucopterus.
" marinus.
Rissa tridactyla.
Pagophila eburnea.
Rhodostethia rosea.
Sterna Anglica.
" Caspia.
" Hirundo.
" macrura.
" Paradisea.
Hydrochelidon fissipes.
Colymbus torquatus.
" septentrionalis.
Podiceps cristatus.

I have omitted the strictly Pelagic or ocean-wandering birds and those belonging to both coasts of the North Atlantic.

No North American birds have yet been found in Spitzbergen—indeed there are there but about 26 species in all, according to Malmgren. The only land birds recorded are *Falco gyrfalco*, *Nyctea nivea*, *Plectrophanes nivalis*, and *Lagopus* var. *hyperboreus*. Of the birds of Jan Mayen's Land, which lies in a direct line between Iceland and Spitzbergen, and nearer to Greenland than to either, I have seen no catalogue; but they probably have some relationship to Greenland species.

Bermuda,[7] in lat. 32° 15′ and long. 64° 51′, is about 700 miles off the coast of the Carolinas, Cape Hatteras being the nearest land. It is nearly on the same parallel with Charleston, and about 900 miles south of Nova Scotia, nearly midway between the latter and the Virgin Islands of the West Indies. The entire group to which it belongs is about fourteen miles in length by about three or four in width. There are no indigenous Vertebrates, with the exception of a lizard (*Plestiodon longirostris* Cope, Pr. Acad. Nat. Sci., 1861, 315), and the birds are entirely North American in character, much like those of the middle United States. The fauna is especially characterized by the existence throughout the year, and the breeding, of the following birds: *Vireo Noveboracensis*, *Galeoscoptes Carolinensis*, *Sialia sialis*, *Cardinalis Virginianus*, *Corvus Americanus* (said to have been introduced), *Chamæpelia passerina*, *? Gallinula galeata*.

In addition to these the following species are supposed to breed occasionally in the islands: *Sphyropicus varius*, *Ardea herodias*.

All the other species appear to be accidental visitors, noted for a day or two one year, and not seen again perhaps for several. By far the greater number make their appearance in autumn only, very few occurring in spring.

There are no West Indian birds, properly so called, in the Bermudas; and the occurrence of *Milvulus tyrannus*, a South American species, is very questionable.

A few species of European birds have been noted in the Bermudas, consisting of *Saxicola œnanthe*, *Alauda arvensis*, and *Gallinago media*.

It will be noticed that the first and the last of these have been found in Greenland, the *Saxicola* on the continent only.

As out of the line of migration of our land birds, it is not likely that there are any regular visitors to the Bermudas, *en route* for other regions, the great majority of the species detected there having, in all probability in most cases, been driven out of their course by storms. They certainly do not all stop *en route* to the West Indies, as many of the species are not found in the latter islands.

[7] See "Ornithology of the Bermudas," "Jardine's Contributions to Ornithology," 1849 and 1850, and "The Naturalist in Bermuda," by J. M. Jones, London, 1859.

The water birds seem to appear more regularly, owing to the fact that many of the species apparently take their flight southward from Nova Scotia and Newfoundland straight for the West Indies, and pass directly over the Bermudas.

In the following list of the birds recorded as occurring in the Bermudas, it will be seen that the greater portion of the insectivorous birds and many of the Raptores occur also in the West Indies; rather more than half of the number visit the latter group.

List of birds recorded as occuring in the Bermudas.[8]

Cathartes aura (W). No. of specimens 1, December.
Falco anatum (W). 2, January, February.
" columbarius (W). Through year, especially in September.
" sparverius. 1, December.
Circus Hudsonicus (W). Occasional in autumn.
Haliætus leucocephalus. Seen.
Pandion Carolinensis (W). Abundant.
Otus Wilsonianus (W). 3.
Syrnium nebulosum. 1, April.
Nyctale Acadica. 1, January.
Nyctea nivea. 3, Autumn.
Coccyzus Americanus. "Thousands," Oct. 1849; a few in April.
Sphyropicus varius (W). Perhaps breeds; December to April.
Trochilus colubris (W). At one time common; April.
Chætura pelasgia. Several; Sept. 1849.
Chordeiles popetue (W). Sometimes very common; April to Sept. 1864.
Ceryle alcyon (W). Common; September to April; regular visitor.
Milvulus tyrannus.?! One; March, 1847.
Tyrannus Carolinensis (W). Abundant; April.
" Dominicensis (W). March and April.
Contopus virens (W). One; April.
Turdus mustelinus (W). Several.
" Swainsoni (W). Two; October.
" migratorius (W). Several; February and March.
Saxicola œnanthe. One each; October, March.
Sialia sialis (W). Common; resident.
Anthus Ludovicianus. One; November.
Mniotilta varia (W). Three; October.
Parula Americana (W). One; April.
Geothlypis trichas (W). One; October.
Seiurus Noveboracensis (W). Abundant in autumn; regular visitor.
Dendroica coronata (W). One; January; several in April.
" pinus. Common in September; several seasons.
" palmarum (W). Two; December.
" discolor (W). One; October.
Myiodioctes mitratus (W). One; March.
Pyranga rubra (W). Several; April.
" æstiva (W). " "
Hirundo horreorum (W). Rare in spring; common Aug. to Sept.; great flight in Sept. 1849.
" bicolor (W). Sept. 1849.
Cotyle riparia (W). August and September.
Progne purpurea. Great flight Sept. 22, 1849.
Ampelis cedrorum (W). Abundant October to December.
Collyrio borealis. One; March.

[8] Species with (W) are found also in the West Indies.

Vireo Noveboracensis (W). Common; resident.
Mimus Carolinensis (W). " "
Eremophila cornuta. Three; October and February.
(Alauda arvensis.) One; June 12.
Chrysomitris tristis. Several; March.
Curvirostra Americana. January to May.
" leucoptera. March to May.
Plectrophanes nivalis. January to February.
Passerculus savana (W). One; April.
Poœcetes gramineus. One; Oct. 25.
Coturniculus Henslowi. Small flock; December.
Melospiza palustris. One; December.
Guiraca Ludoviciana (W). Two; October and April.
Cardinalis Virginianus. Common; resident.
Dolichonyx oryzivorus (W). Nearly every autumn; October.
Icterus Baltimore (W). Two; October.
Corvus Americanus. A few every year; perhaps breeds.
Zenaidura Carolinensis (W). One; March, 1850.
Chamæpelia passerina (W). Common; resident.

Also most of the waders and a considerable number of the swimming birds.

Conclusion.—From a careful consideration of the facts mentioned in the preceding pages, we are, I think, entitled to derive the following generalizations in regard to the interchange of birds between America and Europe.

European birds, especially the land species, reach Greenland and return to the continent by way of Iceland, the Faroe Islands forming a stepping-stone from Great Britain and Scandinavia. In very rare instances species seem to proceed direct to Greenland, without stopping in Iceland, although this may be due to the fact that while visiting Iceland they have not yet been noted there by any naturalist.

The European birds found on the continent of North America reach it by autumnal movement from Greenland in company with strictly North American species.

Birds of North America rarely, if ever, reach England from Greenland by direct spontaneous migration by way of Iceland, as shown by the fact that only three of the American birds occurring in Greenland are found in Iceland, and that few of the American species observed in Europe are found in Greenland at all.

Most specimens of American birds recorded as found in Europe were taken in England (about 50 out of 69), some of them in Heligoland; very few on the continent (land birds in only five instances).

In nearly all cases these specimens belonged to species abundant during summer in New England and the eastern provinces of British America.

In a great majority of cases the occurrence of American birds in England, Heligoland, and the Bermudas, has been in the autumnal months.

The clue to these peculiarities attending the interchange of species of the two continents will be found in the study of the laws of the winds of the northern hemisphere, as developed by Prof. Henry and Prof. Coffin. These gentlemen have shown (see Prof. Henry's articles on Meteorology, "Report of Commissioner of Patents for 1856," page 489) that "the resultant motion of the surface atmosphere, between latitudes 32° and 58° in North America, is from the west, the belt being twenty degrees wide, and its greatest intensity in the latitude of 45°. This, however, must oscillate north and south at different seasons of the year with the varying declination of the sun. South of this belt, in Georgia, Louisiana, etc., the country is influenced, at certain seasons of the year, by the northeast trade-winds; and north of the same belt by the polar winds, which on account of the rotation of the earth, tend to take a direction toward the west. It must be recollected that the westerly direction of the belt here spoken of is principally the resultant of the southwesterly and northwesterly winds alternately predominating during the year."

From these considerations and facts, therefore, we are entitled to conclude that the transfer of American birds to Europe, is principally, if not entirely, by the agency of the winds, in seizing them during the period of their migration, (the autumnal especially) when they follow the coast, or cross its curves, often at a considerable distance from land, or a great height above it. Carried off, away out to sea, mainly from about the latitude of 45° (the line of greatest intensity of the winds) the first land they can make is that of England, whence the fact that most of the species have occurred in the British Islands as well as Heligoland, equally well fitted to attract stragglers and furnish them a resting place. It is probable that, apart from its few permanent residents, the Bermudas are supplied in the same manner.

Iceland being in the latitude of the reverse current, from east to west, such of its species as are caught up by the winds and carried off would soon reach Greenland, only a few hundred miles distant. This may be the principal agency of supply from Europe to Greenland, as most European land birds are only met with there at rare intervals, although as Greenland lies north of Iceland, there may be a regular migration to some extent.

As remarked, the prevailing direction of the winds, whether violent or moderate throughout the year, as well as during the period in which our birds are on either their spring or autumnal migration, is from America toward Europe. Even should their direction be reversed and that rare phenomenon, a summer "northeaster," occur, it would merely have the effect of bringing the birds back upon our own coast, or into the interior, the

line of the storm being in fact about parallel with the eastern shore line of the United States, and its influence extending only a short distance from the coast, and not involving the vicinity of Europe at all. That such storms do affect the movements of our birds is shown in the case of the golden plover. It is well known that this species breeds in immense numbers in the northern regions of America, and that the southward migration in summer and autumn, is principally confined to the region along or near the Atlantic coast. Generally, large flights would seem to start directly from Newfoundland and Nova Scotia for the West Indies, where they are met with every autumn passing still southward into South America, and reaching almost to Patagonia. Usually it is but a comparatively small number that touch and rest along the Atlantic states; but it is well known to the sportsmen of New England that, should a violent northeast storm occur off the coast toward the end of August, unusual flights of plover and curlew may be looked for.[9] This was the case in 1863, when the islands of Nantucket, Martha's Vineyard, and other localities along the coast of Massachusetts, swarmed with incredible flights of these birds. On similar occasions immense numbers have been carried far into the interior of the Atlantic states, furnishing the occasion of a regular carnival for gunners, much as in the case of great flights of the wild pigeon.

Another instance of the influence of northeast storms is in the occurrence of the Stormy Petrel, (Mother Carey's Chickens) and other oceanic birds far in the interior, and even across the Alleghanies, during and after such storms. The collections of the Smithsonian Institution embrace specimens of *Thalassidroma Leachii* killed about Washington in August, 1842, with hundreds of others. I myself obtained at Harrisburgh, Penn., a fine adult Pomerine Jager, *Cataractes pomarinus*, killed on the Susquehanna, near that city, in September, 1839. Adults of the species mentioned are rarely seen within the limits of the United States at all, and in summer the latter would hardly be likely to occur south of Newfoundland.

The present is not the occasion to discuss the nature of that impulse which causes the bird or the fish to retrace its steps in spring so unerringly; the fact is a well established one and of much importance in reference to the multiplication or diminution of species. A region deprived of its spring birds or fishes by extermination will only be filled up again in the course of a long period of time. The result, however, can be greatly accelerated by artificial propagation in the places to be supplied.

[9] Mr. G. N. Lawrence mentions (Annals N. Y. Lyceum, viii, 1864, 100,) that the Golden Plover is always found at Montauk Point on the 28th of August, should a northeast storm occur.

It may be considered as established that the migrations of birds are generally more or less in a north and south direction, influenced very materially by river courses, mountain chains, forests, conditions of moisture, mean temperature, altitude, etc. Middendorf (Die Isepiptesen Russlands) suggests that birds migrate in the direction of the magnetic pole; a suggestion not at all borne out by the facts in North America.

It may be further remarked that while birds proceed generally in the spring to the very spot of birth, and by a definite route, their return in autumn is not necessarily in the same line. Many birds are familiar visitors in abundance, in certain localities in either spring or autumn, and are not known there in the other season. This is a fact well known to the diligent collector, and I have been inclined to think that, in very many instances, birds proceed northward along the valley of the Mississippi, to return along the coast of the Atlantic.

In general the northward vernal movement is performed much more rapidly, and with fewer stops by the way, than the autumnal.

Birds generally make their appearance in given localities with wonderful regularity in the spring, the *Sylvicolidæ* especially; a difference of a few days in successive years attracting the notice of the careful observer; this difference is generally influenced by the season. The time of autumnal return is, perhaps, less definite.

ART. XLII.—*On the Meteoric Fireball of July 13th*, 1846; by DANIEL KIRKWOOD, LL.D., Prof. of Math., Indiana State University.

ON the 13th of July, 1846, at about 9h. 30m. P.M., a brilliant fireball passed over Maryland and Pennsylvania, and was seen also in Virginia, Delaware, New Jersey, New York and Connecticut. This meteor was noticed in many newspapers immediately after its appearance; but I believe no account of it was given in this Journal.

When this brilliant object appeared I was in the parlor of a friend, in York, Pennsylvania. The meteoric light shone brightly into the room, and immediately after, I heard exclamations of surprise from persons in the street. I hurried to the door, but before I could reach a point from which the meteor was visible it had disappeared. The same evening, and also the next day, several citizens of York, who had had good views of the meteor, pointed out, at my request, its apparent path. A few days subsequently I had persons in Chanceford, York Co., Pa. (twenty-

five miles southeast of York, Lancaster City, Pa., and Shawsville, Harford Co., Maryland, to do the same. Among those who saw it in York was my learned friend, Daniel M. Ettinger, Esq., whose statements I regard as eminently trustworthy. Mr. E., it is proper to remark, is a practical surveyor, and hence accustomed to accuracy in the measurement of angles. At York, the least zenith distance of the meteor's track was estimated by Mr. Ettinger to be 10°—doubtless a close approximation to the truth.

The August number of the Literary Record and Journal, a monthly periodical then published at Gettysburg, Pa., contained the following editorial notice of the phenomenon:—

"It appears, from various accounts received from abroad, that the extraordinarily large and brilliant meteor, which apparently passed over our town on Monday the 13th ult., was seen over a wide district of territory. It was observed in places very distant from each other, not only in the direction of its motion, which we would expect as a matter of course, but also at right angles to that direction, which was not expected by those who saw it; each observer having been persuaded that it was near the earth, and that it passed nearly over his zenith. It was seen at points west of Gettysburg, and at numerous places east of it as far as the seaboard.

"At Gettysburg, it seemed to burst upon the view at a point a little west of south, and an elevation estimated at about 30°, to pass about 25° east of the zenith, and to be extinguished at a little east of north, and an elevation of about 30° or 35°. It is very much to be regretted that no observations were made by those who saw it, to determine these items with accuracy."

The next number (September, 1846) contained the following communication:—

"New Haven, Conn., Aug. 8, 1846.

* * * "In the 'Literary Record and Journal of the Linnæan Association of Penna. College,' Aug. 1846, I notice some account of the splendid meteor of the 13th ult. This body was also seen by several persons in New Haven, and tolerably well observed. The observations were published in the Daily Herald of this city, but as I have seen no copy of them in other papers, I fear they have not come to your knowledge, and therefore take the liberty of sending you the principal particulars.

"*Time*, July 13th, 1846, 9h. 30m. ± P.M., New Haven.

Place when first seen.—Az. 69° west of true south; altitude 10°—both uncertain, probably two or three degrees; and moreover the observer probably did not notice the meteor at the instant it became visible.

Place of disappearance.—Az. 87½° west of true north; altitude 7½° to 8°. Azimuth may be one degree more or less; altitude very nearly correct.

Motion, exceedingly slow.—Time of flight not less than 20 seconds. This seems scarcely credible, but the chief observer, who is an exact man, well aware of the danger of over-estimating small portions of time, thinks the time still longer.

Apparent size.—Equal to that of the planet Venus on the average, at the same altitude.

The meteor left no train, emitted no sparks, and did not vary in brightness during its course.

* * * "Several accounts of the same body have come from Pennsylvania, New York and Virginia, but so miserably defective as to be of scarcely any use. * * * The very slow relative motion of the meteor led me at once to suppose that it was travelling nearly in the path of the earth, overtook and passed by it, with a real velocity of perhaps twenty-five miles per second. That point of the ecliptic toward which the earth was then tending was at that hour beneath our horizon and in the N.E. quadrant. The elevation of the meteor at extinction could not have exceeded thirty miles, and was probably somewhat less. Its size must have been very great to have presented at this distance so large a light (for definite disc could not be seen), probably not less than 200 feet in diameter, perhaps more; and yet there is so much danger of illusion that this element should be derived from an estimate of the angular diameter taken as near as possible."

I had furnished the same number of the Record and Journal with an article on this meteor. As published, however, it contained several unfortunate typographical errors. A further comparison, moreover, of the descriptions given of the phenomena led me to a slight modification of my results. As might be expected, some of the accounts by observers were very unsatisfactory and even conflicting. I even found it impossible to harmonize those which separately would have been considered trustworthy. Without further details I will merely state that after various trials the following results were found most nearly in harmony with the best observations.

The course of the meteor's path was north, about 30° east, and its projection on the earth's surface passed about four miles west of Lancaster, Pa., and nearly through Mauch Chunk, in Carbon county. The almost unanimous testimony of those who saw the meteor at Lancaster was that it passed a little west or northwest of the zenith; while a few stated that it passed directly "overhead." When west of Philadelphia, according to a correspondent of the Public Ledger, its angle of elevation was 42°. This would make its altitude above the earth's surface, when near Lancaster, about 59 miles. The place of the meteor's disappearance, as seen from New Haven, was at the distance of about 135 miles, near the south corner of Wayne county, Penn. Its appa-

rent altitude at disappearance being about $7\frac{1}{4}°$, would give its elevation above the earth's surface about 18 miles. It was a little northeast of Lebanon, Penn., when first seen at New Haven, and its distance from the latter was about 189 miles. The corresponding altitude was 33 miles; or if we suppose this angle of elevation to have been 13° (and the writer admits an uncertainty of two or three degrees) the altitude was 44 miles. When nearest York its altitude, according to Mr. Ettinger's estimate of the zenith distance, was about 68 miles; and when nearest Gettysburg, (the zenith distance being 25°), about 70 miles. The point in Virginia to which it was vertical when first seen from Gettysburg was probably about 50 miles southwest of Washington, D. C. The length of the projection of its visible path on the earth's surface was therefore at least 250 miles. The length of that portion observed from New Haven was about 78 miles. When it is remembered that the Gettysburg observation is uncertain to the amount of several degrees, and that those of York and Philadelphia, being but estimates, may be in error at least one degree, entire harmony in our results could not be expected. We may conclude, however, in general, that the meteor's path was far from parallel to the earth's surface; the altitude, when south of Gettysburg, being about 70 miles, and when last seen at New Haven, about 18 miles.

Velocity.—The estimates of the time of flight by different observers were so discordant that nothing definite could be inferred from them. That of the observer at New Haven was perhaps the most reliable. This would give a velocity with reference to the earth's surface of about four miles per second. The heliocentric velocity was probably between 20 and 25 miles per second.

Apparent magnitude.—The estimates of the apparent diameter by persons in York and Lancaster varied from $\frac{1}{3}$ to $\frac{2}{3}$ that of the full moon; while some at greater distances from the meteor's path thought it about $\frac{1}{6}$. The apparent size at New Haven was much less. It is to be remembered, however, that the distance was much greater. Moreover, at York and Lancaster the meteor had a train about 1° in length, while nothing of the kind was observed at New Haven.

Was the disappearance of the meteor followed by a report?—I was assured by persons in Harford county, Maryland, Chanceford, York county, Pennsylvania, and in York, that shortly after the disappearance of the meteor a distinct report like that of a distant cannon was heard. As this was noticed by a considerable number of persons, and in places so remote from each other it is scarcely possible they could have been mistaken. As might be expected, their estimates of the interval which elapsed were different; but Mr. Ettinger of York, who was paying par-

ticular attention in expectation of a report, stated that it was a little over six minutes. This would indicate a distance of about 75 miles. It could not therefore have resulted from an explosion at or near the termination of the meteor's path. Like many others I did not notice this report. This may be explained, however, by the very considerable interval which had elapsed after the disappearance of the meteor, when, no report being expected, a distant explosion would not attract attention.

What became of the meteor.—The inclination of the path to the surface of the earth was such that the body could not have passed out of the atmosphere. Perhaps the entire meteoric mass may have been dissipated before reaching the earth.

The meteor at extinction was nearly equally distant from Gettysburg and New Haven. Hence its apparent altitude at the former must have been about 8°. It would seem, therefore, that the Gettysburg observation as to the point of disappearance was nothing more than a rough conjecture by one not accustomed to measuring arcs by the eye. I am also compelled to adopt the same conclusion in regard to a similar estimate by an observer at Lancaster. To a majority of those who saw it both in Lancaster and York it disappeared behind buildings, so that no estimate could be given. The errors in regard to its apparent altitude when it first appeared, are readily explained on the assumption that few saw it at the first moment of visibility.

Art. XLIII.—*Whitney's Geology of California.*

[Continued from p. 231 of this volume.]

In the preceding part of our notice of Prof. Whitney's Report on the Geology of California, we considered that portion relating to the Coast Ranges. We will now notice the Sierra Nevada, and such other matters treated of in the Report as our space will allow, following as nearly as is convenient the order the author pursues.

The Sierra Nevada.

This mountain chain, the grandest in the United States, possesses a peculiar interest from whichever point of view considered. Possessing, as it does, the highest peaks in the country, so far as is known, and perhaps the greatest magnitude of mass of any chain in North America, abounding in the grandest scenery, containing mines the products of which have changed commercial values throughout the civilized world, and which have stimulated an emigration that has built up eleven states and territories west of the meridian of 103° within seventeen years,

seven of which states and territories lie entirely on the west of the Rocky Mountains; a chain about which so much has been written and yet so little accurately known previous to the publication of this Report, we turn therefore with special pleasure to the facts here published.

As stated respecting the chain, in the last number of this Journal, it has the direction N. 31° W., from Mt. San Jacinto to Mt. Shasta, a distance of about 600 miles.

The region *popularly* known under the name of Sierra Nevada, extends from the Tahichipi Pass to Lassen's Peak, about 430 or 440 miles. For this distance the chain is very continuous and unbroken, and preserves many common features. It is from 75 to 100 miles wide, generally between 80 and 90 miles, and has everywhere a long gradual slope on the western side to the Great Central Valley of California; while on the eastern it descends precipitously to the elevated valleys and deserts of the Great Basin. The culminating peaks are nearly in a straight line, and, although near the eastern edge, yet the water-shed is generally still farther east of this line.

The chain consists essentially of an immense core of granite, flanked on either side by metamorphic slates, and more or less covered by lava, this latter increasing in quantity as we go north. The culminating points in the *southern* portion are of granite, in the *central* of slates (belonging to the eastern flank), and the *northern* of volcanic rocks. In regard to the comparative ages of the Sierra Nevada and the Coast Ranges, the Report says, "we consider all those chains or ranges of mountains to belong to the Coast Ranges, which have been uplifted since the deposition of the Cretaceous formation; those, on the other hand, which were elevated before the epoch of Cretaceous are reckoned as belonging to the Sierra Nevada."

In passing along the foot hills of the chain, at its western base, we find at numerous points the marine Tertiary or Cretaceous, or both, resting in a horizontal position on the upturned edges of the slates and metamorphic rocks of the auriferous series. At the southern end of the great valley, near Fort Tejon, as we skirt the base of the mountains which close entirely around like a grand amphitheater, we pass suddenly from the undisturbed Tertiary to rocks of the same age and series highly inclined; and, in so doing, we pass from the Sierra Nevada to the Coast Ranges, although the chains form a perfect topographical junction. And, again, at the northern end of the valley, in Shasta county, the Cretaceous strata lying to the east of Sacramento river are horizontal, while on the western side they are highly disturbed.

These horizontal strata may be traced at intervals for over 400 miles, forming a narrow belt at the western base of the

chain, not however continuous, but occurring in patches, some very small and others large, the larger lying nearer the two extremities, the central portions, as might be expected, having been more extensively swept away by denudation. Portions are highly fossiliferous. To the north the Cretaceous predominates, and the fossils are numerous and especially well preserved; in the south Tertiary predominates, and the fossils are fewer and in a poor condition.

These marine strata do not extend to an altitude of more than 1000 feet, except at the extreme southern part, where they occur at a height of over 1200 feet, if the altitudes given upon the maps of the Pacific R. R. explorations are to be relied upon. They are nowhere worked for gold, and are not to be confounded with those extensive fresh-water deposits which occur so frequently in the mining regions, which sometimes extend up to a great height, and often contain the precious metal in quantities sufficient for profitable extraction.

To the south of the latitude of Sacramento they are entirely Tertiary. The most considerable mass commences near White river and extends to the head of the valley. Between White and Kern rivers they form a belt denuded into rounded hills from 200 to 600 feet high; the rock is soft, easily decomposing, and the hills dry and treeless. They rest on a floor of granite which is exposed by denudation at frequent intervals. Wherever fossils have been found, they are in poor preservation and have been referred to the Miocene. South of Kern river the deposits are widely distributed, but are not so extensively denuded.

Passing north, occasional patches occur at intervals to the American river at Folsom. Here the first Cretaceous rocks occur, which become more common as we travel north.

Near Pence's Ranch, in Butte county, the relations of these strata to the auriferous and volcanic series are most beautifully seen. Resting on the edges of the auriferous slates, which here dip to the east at a very high angle, are the highly fossiliferous Cretaceous shales perfectly undisturbed; and on these again are strata supposed to be Tertiary; and these in turn are covered by tables of basaltic lava. North of this the strata are mostly overlaid by beds of lava, but in a number of streams, cañons have been worn to such a depth that they cut through into the fossiliferous beds beneath, so that the formation was found at intervals nearly to Pitt river.

Of more interest to the general reader is the great *auriferous belt* along the western slope of the chain.

Auriferous Belt.—The auriferous region of the state is not exclusively confined to the western slope; but this portion will be first noticed.

This belt may be said to begin in the neighborhood of Tejon Pass, and to extend through the state and across its northern borders into Oregon. The gold region reaches still farther in each direction, north and south, of which 700 miles or more in length lie within California.

But to return to the western flanks of this chain. Owing to geological peculiarities different portions of this slope are of very unequal importance as gold-producing regions. That portion lying south of the San Joaquin is generally barren; but gold occurs in a few places, and commonly not so near the base of the chain as farther north, and mostly on or in granite.

Commencing at the southern end of the chain, popularly considered, that is, near the Tejon Pass, there is but a very moderate development of metamorphic slates. At the Tejon Reservation they are represented by a narrow belt of mica slates, associated with some crystalline limestone. For 150 miles, travelling north, they are feebly represented, forming but a narrow belt; in some places isolated hills of highly altered rocks, standing in front of the granitic slope of the main chain, in others forming the base of the chain itself, but rarely if at all yielding gold enough to repay working. Where gold occurs, it is farther east within the chain and on or in the granite. These mining regions we will notice in this place before passing to the more productive slates north.

A belt of auriferous rocks extends within the chain from the Tahichipi desert northward to the Kern river, which is sufficiently productive to be worked at intervals. Some few placer mines occur in the Tahichipi Valley, and again in Walker's Basin ("the Park" of the Pacific R. R. maps); but whether the gold is derived from granite or the truly metamorphic rocks, is not known. Near the Kern river, especially about Keysville and Greenhorn, are more extensive workings, entirely on granite. Several fine quartz views occur, some of large size, and a few have been worked with profit. One near Keysville was visited which had been highly productive. It was entirely in granite, the vein well defined, and the yield satisfactory. Numerous placer mines occur, and considerable quantities of gold have been sent from this region. It generally assays lower than that from the slates farther north. Placers occur at intervals to White river; but north of this there are none of much extent until we reach the San Joaquin.

In passing north from this last point the metamorphic slates rapidly increase in breadth and importance, and before traveling thirty miles we reach the great auriferous region of the State, which forms a continuous field for more than 200 miles, and which has yielded perhaps nine-tenths of the gold that has been produced in the State. This lies mostly on the metamorphic

slates which continue to expand in width as we pass north, but it laps over on the granite at numerous points.

The precise area of this field cannot be given in the present state of our knowledge; it probably embraces six thousand or more square miles. To the north it is covered by the heavy beds of volcanic rocks that have overflowed the auriferous series. The settlements of the whole western slope, in and adjacent to this region, are mostly confined to the gold-producing portions. The lands as a whole have little value for agricultural purposes, so that the richer the mines the denser the population.

We will briefly consider this gold-field, commencing at the south with Mariposa county.

The great feature of this county, economically considered, is the so-called "Mariposa Estate," on which are some of the most noted mines in California, and which, on many accounts, have attracted much attention both at home and abroad. This estate embraces about seventy square miles of territory, extending from the Merced river, southeast, for about sixteen miles, on the line of the great quartz veins of this region. Placer mining has been carried on here since 1849 and quartz mining was attempted as early as 1852. The magnitude of some of the quartz-lodes, and their rich yield of gold, at times, might well give rise to hopes of boundless wealth—expectations that, thus far, have not been realized.

The geology of the estate has been examined in some detail by Mr. King, and many interesting features noted, only a few of which can here be mentioned.

The topographical features of the estate are strictly subordinate to the geological structure, the courses of the streams and of the mountains being in the main parallel with the strata. Through the center is a broad belt of slates, and on each side of this are belts of sandstone, mostly in a highly metamorphic condition; these, in turn, have masses of slate outside of them, of which but small corners fall on the estate.

Subordinate to these belts of slate and sandstone are masses of serpentine and beds of limestone. The extreme southern end of the estate is occupied by granite, which cuts across these belts and extends, on either side, beyond its limits.

The slate belt is of the most interest to the public, for in it are the larger part of the gold-bearing quartz veins here so numerous, and on it have been the most considerable placer mines. The strike of the strata is not uniform. Along the southern end the direction is N. 54° W. for over seven miles. Then occurs a break, extending across them, where the slates are much broken and confused. North of this, the strike is N. 28° W., a change of 26°. This portion extends from the Ophir to the Pine Tree mine. Near this is another break, where the

strata again change the direction of their strike 26°, and then continue in the direction of N. 54° W.

The slates on each portion are remarkably parallel, and have every possible degree of metamorphism, and in places have sandstones interstratified with them. They dip at all angles, but always to the east.

The quartz veins are very numerous, and generally have the same direction as the strike of the slates, or very near it. Those occurring in the granite are commonly parallel with those in the slates, but some are at right angles to them. Parallel with these cross-veins in the granite are dikes of trap generally of small size.

Some of the quartz-veins are noted for their size, and are indeed the most remarkable known in the State. In the Pine Tree and Josephine mines, near the north end of the estate, the average breadth of the quartz is fully twelve feet, and in places it expands to forty feet, all of solid vein-stone. As with most of the other quartz-veins of the region the gold is very unequally distributed through the vein, and only portions pay for working. This is the great reason why their yield of the precious metal, and the profit of its extraction, have been so very variable and uncertain. The processes of extraction, however, have not always been the best, or the most economical.

The Princeton mine, six miles southeast of the mines last named, is the most extensive, and has yielded the most gold. The works extend to over 500 feet in depth, and over 1400 feet in length, and the yield is stated to have been about $2,000,000. But we cannot enter into further details.

It was near the Pine Tree mine that Mr. King discovered, first in Jan. 1864, those Jurassic fossils which indicated unmistakably the age of these slates. Some of them were found within a few feet of the vein.

A line of very heavy outcrops of quartz commences at the Pine Tree and Josephine mines and extends northwest nearly 70 miles to Jackson, in Amador county. Many persons have supposed this to be one vein. If it cannot be proved that these are continuous, and in fact one great lode, it is certain that these many enormous masses of quartz are on nearly a straight line for the distance named, and that the principal quartz-mines and heaviest placer diggings of Mariposa, Tuolumne, Calaveras and Amador counties are on or near this line.

In Mariposa county there are scarcely any of those superficial volcanic accumulations that so modify the mining features to the northwest. Hence, there are few or no "deep diggings" or great hydraulic washings; the placers are more shallow, and, as a consequence, sooner exhausted.

In passing northwest the next county entered is Tuolumne. In this the volcanic rocks become more abundant; and they continue to play a more important part the farther we proceed in this direction along the western slope, until, in Butte, Plumas, Shasta and Siskyiou counties, the immense quantities of these materials that have been ejected from the very numerous craters and vents have covered up most of the auriferous deposits.

Tuolumne, like Mariposa county, lies partly in a high mountain region on its eastern side, and sinks into the mining belt on its western. The latter part is about twenty-five miles wide, and contains nearly all the inhabitants and wealth of the county. Over the auriferous deposits there are some extensive volcanic deposits which determine the character of the mining. Here we find more hydraulic workings and deep diggings. In these have been found the remains of more large animals, the elephant, mastodon, etc., than anywhere else in California. The auriferous rocks proper need not be noticed more in detail than to state that they are of the same kinds found in Mariposa county; that there is the usual variety, both as regards age and metamorphism; that the truly metamorphic rocks are often cut by trap or granite; and that there is a much greater development of crystalline limestones, and these generally occur near the eastern edge of the metamorphic belt. No recognizable fossils have been found in these limestones; but their position indicates that they are the same that have been pronounced Carboniferous by Mr. Meek, who has examined the fossils found in other localities on the same line. The gold extends into the granite adjacent the metamorphic strata.[1]

In this county the system of mining known as "Table Mountain mining" is seen in the greatest perfection perhaps in the State; and, as it has been seldom described, we will notice it more at length than the other systems.

The volcanic materials, in this part of the State, have issued almost entirely from regions lying east of the true mining belt, and generally comparatively near the crest of the Sierra, and they have flowed down the western slope in immense quantities. Sometimes this has been in the form of liquid lava, which has descended by the old river courses, more or less filling the old valleys, and hardening into basaltic masses. At others, it has spread out into immense sheets, like strata, and thus hardened, effectually covering the auriferous gravels. In this way it overlies immense areas farther north. In others, it has been ejected in the form of ashes, which have been arranged into strata by water or other means, and afterward solidified to various degrees

[1] Here it should be understood that I use the term *metamorphic* only for rocks not granite, or granitic, for convenience merely, and without advocating any theory in regard to the origin of the granite.—W. H. B.

of hardness. In still others, the finer ashy materials have become suspended in fresh water which formed large lakes along the flanks of the chain, and thus deposited in sedimentary strata, of various colors and hardness, and often rich in fresh-water infusoria.

The term *cement* is often applied to certain forms of these consolidated volcanic materials, commonly to the breccia, or coarser materials; but the term is used loosely, and is often applied to true auriferous gravels now hardened. To notice all the phases that these superficial volcanic deposits assume, or all the modifications they give rise to in mining, would exceed the limits of this article; we will therefore notice but one, "Table-Mountain Mining."

As before stated, the lava often flowed down the old river valleys, and then consolidated into very hard basaltic rock. Such a mass has withstood the denuding effects of later times much more completely than the slates on either side. Hence, the streams have cut new channels; and, at present, these basaltic streams are left as tables, capping ridges between the present water-courses, and imparting a most peculiar aspect to the scenery. The basaltic mass is often bounded on either side by steep slopes, sometimes walls of rock nearly vertical; and its top is a very gentle slope descending to the west, remarkably regular as a whole,—a dry, rocky, barren table of dark basalt, supporting a scanty growth of shrubs and stunted trees, in marked contrast with the hills of slate that have a more rounded outline, and are covered with more soil, and support a more vigorous growth of vegetation, and which slope away from the base of these walls into the deeper cañons or valleys on either side.

The denudation that has taken place since the period of eruption has been extraordinary. The Stanislaus river has cut through the main table-mountain of this county, in one place, and now runs about 2000 feet beneath it, in a narrow valley or mere gorge. And in other parts of the State evidence is cited of even much greater denudation. On the Middle Yuba, on the north side of Pilot Peak, the slates have been cut 3000 feet below the base of the lava which forms the summit of Pilot Peak and the adjacent heights, which lava is here about 650 feet thick. Instances might be greatly multiplied in proof of the stupendous amount of denudation.

Of course this lava now covers the auriferous gravels that were superficial before its flow,—the "flats," "bars," "gulches" and "bottoms," that form the rich placer-grounds of those early ages. Here it has been safely kept from harm and locked from sight. But it was not secure enough to escape the knowledge of modern "prospectors," who have found it out, and

drive a profitable business in mining these old river-beds and flats.

Where the lava has flowed in a valley that is comparatively narrow, the Table-mountain is now narrow, and the old river bed, with its gravel and gold, is somewhere beneath it, but lower than the junction of the basalt with the slates on either side. Accordingly, a drift (or *tunnel* as it is universally called in these mines) is run beneath this basalt, through the slates which once formed the sides of the valley. This portion of the slates is called the "Rim-rock." The old river-bed is found, its gravels laden with the precious metal is carried out through the tunnel by means of cars, and the gold separated by the usual processes. Sometimes immense quantities of these gravels exist. The entire thickness of these old detrital beds, in one place, is at least 200 feet. But all is not "pay-dirt" or "pay-gravel."

But other strange things are found besides gold. The old valley has come down to our times more perfectly preserved than Herculaneum and Pompeii, which, long after, were covered in a similar manner. There are the old arrangements into fine and coarse materials, made by the current and old waterfalls and cascades, with the rich "pay-gravel" in the pools at their base, so long dry; there are beds of fine clay that were formed by eddies in quiet pools, preserving between their thin laminæ the leaves of the trees that clothed the old hills where now the valleys are 3000 or 4000 feet below the surface they then had; and there are bits of wood, and even entire trunks of trees, sometimes silicified; and the teeth and bones of animals that fed in those old forests;—in short, such things as would be found by a modern river, except that the remains of the animals and plants belong to extinct and not living species. These organic remains have not yet been investigated. Dr. Newberry, who has hastily examined some of the leaves, refers them to the later Pliocene age. So far as they have been studied, it seems that the fauna that flourished just before, and at the time this volcanic convulsion came on, was entirely distinct from that which flourished later, the Post-tertiary remains, which figure so very conspicuously in many placer-diggings. Those beneath the volcanic deposits appear to be late Pliocene, while those found in the other auriferous detritus are Post-pliocene. The remains of the elephant and mastodon have thus far not been found beneath the volcanic beds; at least there is no authenticated instance of it. It seems that the great volcanic disturbance that closed the Tertiary period in the State exterminated the Tertiary higher animals, and then came those later ones: the elephant, bison, tapir, horse (two species), mastodon, &c., the last of which apparently became extinct after the advent of man. In this county, stone mortars and mastodon bones have been found together in

the diggings in several cases. We expect most interesting results from a careful study of the vertebrate remains, which we trust they will receive.

Farther north, where the lava has flowed over extensive flats and slopes in sheets rather than in streams, the gravel is often worked beneath the beds. For reasons obvious to the reader, the presence of a "rim-rock" of slates beneath the lava is considered desirable by the miner, indicating, as it does, that he is at work in an old valley; but there are many cases, especially in Sierra county, where "table-mountain mining" has been profitable although such "rim-rock" was not found,—where the lava sheets had spread over more extensive flats, one edge of which is now denuded, the other not yet being found even in extensive workings.

With regard to the next county north of Tuolumne, namely, Calaveras, we will only notice the copper mines lately so famous and so productive. The principal claims are located on two parallel belts five or six miles apart, one of which lies along the base of the Bear Mountain Range; the other follows a broken range of hills, called the Gopher Hills. The first is rather regular, and claims have been located in regular sequence for some twelve miles in length, the direction of the productive part of the lode being about N. 30° W., the claims curving to the northward as it goes west. The other line is more irregular and the mines have been far less productive.

The deposits of copper ore in this region, as in nearly all others in California, do not appear to be included in regular fissure veins, but rather form independent masses lying in the direction of the strike of the enclosing rocks, and dipping with them. But, though not exhibiting all the characters of true veins, some of these deposits are of enormous dimensions and of remarkable purity and richness. The first important discoveries were made in July, 1861, and the first house of the now thriving town of Copperopolis was built the following September.

At present the two principal mines at Copperopolis are the "Union" and "Keystone," both of which are opened on an extensive scale, and have sent large quantities of ore to market. In the Union mine is one of the largest deposits of ore ever struck in any part of the world. The shipments have been on an immense scale, and the ore is of great richness. At the 200-foot level the lode is 21 feet wide, at the 250-foot 31 feet, and composed of Nos. 1 and 2 ores. At the latest accounts the lowest levels had reached a depth of over 400 feet, and the mine continued still to be rich.

The ore is copper pyrites, more or less mixed with iron pyrites, the latter in some of the mines greatly reducing the per-

centage of copper. Copper mines occur in various other places in the State. Some in Plumas county promise well, and others in Del Norte county have sent some ore to market of great richness; but thus far the yield of all the other mines has been insignificant compared with that from those of Calaveras county. The shipments of ore from the State have been as follows:

1863, - - -	5,933 tons, valued at		$512,925
1864, - - -	14,325 "	" "	1,094,660

We have not yet complete returns for 1865. The newspapers state that the Union mine shipped an average of 1000 tons per month, and the other mines of the vicinity 350 per month. These figures would give over 16,000 tons from this locality. Furnaces have been erected the past year at some of the mines to reduce or concentrate the purer ores, but we have no reliable data relating to their success.

In this article we cannot notice more at length the mining matters of the western slope, although they are treated of in considerable detail in the volume before us. We will merely glance at some of the more interesting geological features.

As we pass north, the physical aspect of the Sierra changes with the geological structure. The crest of the chain becomes lower, the passes lower, the granitic core of the chain narrower, the belt of metamorphic rocks on the western slope correspondingly wider, and the superimposed volcanic grows more abundant, it covering a greater area and being of greater thickness. North of the Truckee Pass the culminating peaks are all volcanic; south of that point they are of granite or metamorphic slates.

With the increase in the breadth of the region of metamorphic schists there is a corresponding increase in the breadth of the mining region, until it is 60 or more miles wide; but large areas are covered up by the volcanic. In these larger areas of slates, it frequently happens that considerable portions have escaped the usual metamorphism.

We are now led naturally to consider the question of the age of the rocks of the auriferous series in California. They have been regarded as older than the Carboniferous by all writers on the subject previous to the publication of the Reports under consideration. The announcement, therefore, of their later age has created unusual interest among geologists. We will, therefore, notice with some detail the paleontological evidence. The earliest labors of the Survey led to surmises that the rocks really belonged to later formations; but we will here notice only the proofs that subsequently confirmed these surmises, and the principal data upon which our present conclusions rest. For convenience we will consider these historically, and

begin at the north, since in that direction the first fossils were found.

At Bass' Ranch, near Pitt river, (about lat. 40° 45′ N.), there is a large development of the limestone formation of the Sierras. It is highly altered and forms several hills of considerable altitude. Dr. Trask first noticed fossils in these limestones, and mentions the locality in his Report of 1855, where he refers them correctly to the Carboniferous; but the material was too incomplete for a satisfactory conclusion. Placer mines occur in the region but not in the immediate vicinity, and the relation of these limestones to the true auriferous rocks, and to the chain of the Sierras, could not there be made out, nor indeed whether the limestones were identical in age or not with those of the true mining belt farther south.

In 1862 the party visited this locality and collected a large amount of material, which was immediately submitted to Mr. Meek for a critical examination, and he referred the species to the Carboniferous. Dr. Trask generously placed his original fossils in the hands of the Survey to give greater completeness to the collections.

The descriptions of such of the species that could be satisfactorily determined were published in the first volume of the Paleontological Report, (plates 1 and 2). These species numbered fourteen, of which only four or five were referred to species before known. A number of others were too imperfectly preserved to be satisfactorily determined. Later in the same year, fossils were found at Pence's Ranch, 80 miles southeast of the last locality, in the limestones that are enclosed in the true auriferous slates. These, though imperfect, were considered identical with those of Bass Ranch. Other fossils, also imperfect, but apparently of the same age, have since been found near Genesee Valley, in a similar rock. All these limestones are of the same lithological character, and there seems little doubt that all the patches are of the Carboniferous age that lie in nearly a direct line from north of the Klamath river to the Tahichipi Valley, a distance of over 500 miles. This line is almost precisely parallel with the assumed axis of the chain. Whether or not the other masses having the same character that lie to the east of this line are also all Carboniferous, is not proved, but we are led to infer that they are so from their character, from the fossils found near Genesee Valley, and from their stratigraphical position.

In the same year, Triassic fossils were found in several places east of the Sierra Nevada, in the (then) territory of Nevada. They were found by Prof. Whitney, near Dayton, and by Messrs. Gorham, Blake and R. Homfray in several localities in the Humboldt mining region.

The next year, 1863, the party made a most interesting discovery of fossils on the north slope of Genesee Valley, in Plumas county. The Carboniferous, before spoken of, with the Triassic and Jurassic were all in place. The Triassic were found at Gifford's Ranch in calcareous slates, and some of the species are identical with those from the Humboldt mining region. These have been described by Mr. Gabb and are figured in the Paleontological Report on plates 3, 4, 5, and 6. About four miles west of this, north of the valley, were found more than a dozen Jurassic species in slates and sandstones. They were described by Mr. Meek and figured in the same volume on plates 7 and 8. These were not only the first Jurassic species, but also the first fossils of any kind found *in situ* in the true auriferous slates of the State. The same year Mr. Gorham Blake obtained a fossil near Spanish Flat, in El Dorado county, which appeared to be identical with a Humboldt species, and a similar fossil from the same place, an imperfect cast, had been in the possession of Dr. Trask for some time previous. These were found in the rich mining region of that vicinity, but neither was in place. The same autumn Mr. Gabb succeeded in finding, in this same region and *in place*, imperfect remains of Cephalopods which cannot be distinguished from the Belemnites found later on the Mariposa Estate.

During this same year several new localities of Triassic fossils were found east of the Sierra Nevada. One single specimen was found by Dr. Horn east of Owen's Lake, some 200 or 300 miles south of the Humboldt localities, and Mr. Rémond found others in Sonora, Mexico, at San Marcial.

The next winter, Jan. 1864, Mr. King found the fossils on the Mariposa Estate already spoken of, and this was followed the same year by further discoveries by him and by other persons. Those in the possession of the Survey are described and figured by Mr. Meek in an appendix to the volume before us.

The next year, 1865, Mr. Rémond, having returned from Mexico, resumed his position on the Survey and made a more critical examination of the strata in detail. His labors were rewarded by the discovery of many new localities of fossils extending from Mariposa to the Stanislaus river, some of the species being identical with those of Mariposa and others new. These discoveries were noticed in the last number of this Journal, but no detailed description has yet been published.

The occurrence of these fossils for a distance of more than 250 miles along the western flank of the Sierras, and in so many localities, leave no doubt in regard to the true age of the auriferous slates of California. We omit here many minor details, and those other geological features that lead to the same conclusion. We can, however, more strongly affirm the state-

ments of Prof. Whitney made in the preface to the volume on Paleontology, and in this Journal nearly two years ago, that "we have not a particle of evidence to sustain the theory which has so often been brought forward that all, or even a portion, of the auriferous rocks are older than the Carboniferous,—not a trace of any Silurian or Devonian fossil ever having been discovered in California, or indeed anywhere to the west of the 116th meridian."

We showed in our previous article that, on the other hand, gold occurs in the Coast Ranges in very numerous localities, sometimes in workable quantities, in rocks as new as the Metamorphic Cretaceous.

The fact seems proved, also, that the silver mines on the eastern side of the Sierras are at least in part in rocks of Jurassic age; and the evidence is very strong that all the principal gold and silver mines of the Pacific states—now known to extend eastward more than 250 miles from the western base of the Sierra Nevada, and north and south from British Columbia to Mexico—are of this series. We may look to the facts demonstrated by the labors of this Survey for a key to solve the intricate problems of Mexican geology also, which up to this time have baffled so many geologists.

In the extreme northern counties the auriferous rocks do not differ in their lithological characters from those of the true Sierras, but no fossils have thus far been found in them north of lat. 41°, within the state. The series, however, widens to the westward, until north of the Klamath river it extends quite to the coast of the Pacific.

In the tier of counties lying north of the head of the great valley, there are numerous placer mines, extending to the very sea shore, and quartz veins have been worked to a limited extent. This region is very rough, the topography complicated, and, owing to the absence of surveys, but little is known more than its general features. Peaks rise to 8000 feet in each of these counties; the higher points west of the Sacramento river are granite, so far as is known, and those on the east are volcanic. There are frequent intrusions of granite or similar rocks in the region named, west of the Sacramento, apparently not only forming the core and culminating points of the higher ridges, but occurring frequently in other masses. The placer diggings are scattered over a large area, and in the aggregate they have afforded a large amount of gold.

The most of the northeastern part of the state is covered by lava. One patch, continuous or nearly so, covers an area of not less than 10,000 square miles within the state, and extends beyond the borders in the little known regions adjacent on the north and east. Cretaceous strata pass beneath this lava on

the north and south sides of Mt. Shasta, and also at numerous points along the eastern side of the Sacramento valley for nearly a hundred miles south of Pitt river. In places these volcanic rocks have an immense thickness; in fact, the lofty Mt. Shasta and Lassen's peak are but enormous piles of these volcanic products.

These two prominent peaks are the grandest objects of northern California. Both were ascended and measured barometrically by members of the survey, the former in 1862, the latter in 1863.

Mt. Shasta is a very regular cone, rising to an altitude of 14,442 feet from a base of 2800 to 4000 feet on its different sides. Its profile is very symmetrical, its sides steep, and its summit sharp. Rising 8000 feet above any near surrounding object, its base clothed in forests of the magnificent Conifers for which the Pacific coast is famous, its upper 6000 feet white with perpetual snow, its regular outlines cut with wonderful distinctness against the intensely blue and clear sky of that delightful climate; it forms a feature in the landscape of wonderful beauty and grandeur. Its ascent is neither dangerous nor difficult considering the great height. Wind, will and muscle are the only requisites. The view from the summit is extensive and sublime, but is surpassed by that from its inferior neighbor, Lassen's peak. The remains of an old crater exist near its summit, and emenations of steam, hot water, sulphur, and gases are now its only symptoms of activity.

Lassen's peak lies about eighty miles southeast of this, on the line of the crest of the Sierras, and is 10,577 feet above the sea. Here there is a better defined crater, and about it a greater variety of volcanic products. The view is also much more extensive, embracing, between the extreme limits of vision, the enormous area of 50,000 square miles, or a distance of 380 miles from north to south, and 260 miles from east to west. The peak is less regular in outline, and it rises from a much higher base than Mt. Shasta. On its broad flanks are a large number of smaller cones, many with craters in their tops, some of which are of remarkable regularity. On the southeast side of this peak, at an elevation of 5000 or 6000 feet, are a number of very copious *hot springs*, where most interesting chemical phenomena are taking place. The basaltic lava is being decomposed on an enormous scale, the siliceous portions partially dissolved, and some phases of metamorphism can be well studied. In fact, hot or warm springs are very numerous in the state, along its entire length, too numerous for even an enumeration in this place.

The immense mass of the higher Sierras, lying between the latitudes of 35° and 39°, was left unnoticed in our consideration

of the western slope of the chain. Here is found the greatest magnitude of mass, the loftiest peaks, the deepest cañons, the highest waterfalls, and the sublimest scenery of the state. The chain was crossed by the party at eleven places between these parallels, and a large number of peaks ascended,—a most laborious work, as can be believed when we consider the rough character of the country, its remoteness in most parts from civilization, its great altitude, the absence of previous information respecting large portions of it, the cold, and the many other difficulties to be surmounted. Some few facts will bring these more vividly to the mind.

South of the Truckee Pass, for about 300 miles, there is not a pass below 6000 feet. For 250 miles south of the Placerville Pass there is not a pass below 7000 feet. For nearly 200 miles from the Sonora Pass southward there is not one below 10,000 feet, while for 150 miles there is not one below 11,000 feet, and for a hundred miles not one below 12,000 feet. At least none are known. The culminating point is near lat. 36° 30′, where the highest peak (named Mt. Whitney in honor of the director-in-chief of the survey, by the party who explored this region) is about 15,000 feet.

Near this, within a radius of 25 or 30 miles, nearly a score of peaks rise to 14,000 feet or higher. These peaks are all of granite, which rock here occupies nearly the entire width of the chain (nearly or quite 80 miles wide). Cañons from 3000 to 6000 feet deep abound; and everywhere above 4000 feet, but especially from 6000 up to 11,000 feet, are traces of former glaciers on a most stupendous scale, the glaciers themselves having disappeared. Large areas of rocks are polished, and immense moraines are common. Heavy forests clothe the slopes between the altitudes of 4000 and 9000 feet. Below the former altitude we have the scattered trees and shrubby vegetation of the hot and dry foot-hills, and above the latter up to 10,000, or in places up to 11,000 feet, the stunted growth of alpine species. These last are largely composed of small trees and shrubs; above these limits are the desolated slopes of snow and granite. Here and there a grassy flat is found in some valley; but the green pastures that form such an element in the alpine scenery of Europe are entirely absent. Hundreds of little lakes and ponds nestle in the valleys or occupy the beds of old glaciers, as clear and as blue as the sky they reflect. Some were seen frozen over in midsummer, and many of them are doubtless frozen the most of the year.

The desolation of these higher solitudes, the deep silence that rests upon them, the intensely deep blue of the clear sky, nearly cloudless by day and entirely so, except at rare intervals, at night, the deep blackness from which the stars and moon shine

with a peculiarly white silvery luster, the air fragrant with the odor of firs and balsam, warm and genial by day but intensely cold at night, the wildness of the region so seldom visited by man, the peculiar forms of vegetable and animal life,—all conspire to produce an effect on the mind of the explorer that cannot be imagined by others, even by one familiar with the grandest scenery of the Alps.

The high peaks a hundred miles farther north, near Lake Mono, are of entirely different aspect. Mt. Dana rises to an altitude of 13,227 feet, and has a more rounded outline. This as well as its neighbor, Castle Peak, which is about 13,000 feet, consists of metamorphic slates. These slates belong really to the eastern slope, but here form the crest; and a little farther south they become enclosed in the granite and finally end within the chain.

Mt. Dana will doubtless soon become the resort of tourists, being very accessible from the Mono Trail, which runs along by its southern base, and lying directly back of Yosemite valley. It is rare indeed that so much sublime scenery can be found within so short a distance as within the forty miles from Yosemite valley to this peak. The ascent is easy, and the view extensive, embracing the whole western slope on that side, and extending to the coast ranges, which in places are 200 miles distant; and in the opposite direction reaching far over the deserts, and the many mountain chains that rise from them.

The eastern slope is everywhere very precipitous along this part of the chain. From both Mt. Whitney and Mt. Dana, the *average* slope from the summit to the eastern base amounts to 1000 feet per mile, portions of the declivity being of course very much steeper. And such slopes as these are common in the higher Sierras, even on slopes as much as 6,000 to 10,000 feet together.

Yosemite valley lies in the broad granite belt of the center of the chain. It has been so often described that we omit any particular notice here. Similar valleys or cañons occur on the other rivers south, in the same belt of granite, having the same general features, which are most probably of the same origin. Some are even deeper than Yosemite, but no other one possesses so much to interest the tourist, or is nearly as accessible. Those on the Kings and Kern rivers are especially deep and grand, but they lack some of the most striking features of the Yosemite, especially the immensely high waterfalls.

For further particulars respecting this intensely interesting region we must refer to the Report, which treats of it at considerable length.

Everywhere to the east of the Sierra Nevada, within the state, the country as a whole is a desert. Limited valleys are fertile,

where water may be obtained for irrigation, and in a few such places the soil is very productive; but the region is a most inhospitable one, and portions of it are absolutely unknown to civilized man.

North of lat. 35°, to the Oregon line, the water that drains the eastern slope of the Sierras runs into closed basins, where it sinks into the sands, or forms salt lakes having no outlet to the sea. These form part of the Great Basin lying between the Rocky Mountains and the Sierra Nevada. To the south of this the Colorado river drains a region of similar physical characters. The southeastern part of the state, to the extent of perhaps 30,000 square miles or more, lies in these deserts.

Our geographical and geological information relating to this region is exceedingly limited. It is, however, sufficient to render it certain that some of the data which have been furnished the public from official sources, on both regions, are of a very unreliable character. This much is known: that there are many chains of barren mountains, having in the main a north and south direction, with desert valleys between, some of which are sinks of streams; that at least one of these valleys, Death valley, is below the level of the sea; that portions of the Colorado Desert have been stated to be also lower; that the other valleys lie at various elevations up to 6500 feet, the altitude of Mono Lake; that the mountain chains are made up of volcanic, granitic and metamorphic rocks; that the latter are probably of the same age as those of the auriferous veins of California, Triassic and Carboniferous fossils having been found; that Tertiary rocks occur; and that the region has become very much drier since very recent geological times. It is certain that large areas now dry or occupied by salt lakes of limited size were at a late period covered by lakes or inland seas that have gradually wasted away as the climate has grown more and more dry. These had their development perhaps at the time when those stupendous glaciers existed in the higher mountains, whose traces are now so very abundant, especially in the high Sierra Nevada. A great number of most interesting questions arise in connection with this region, some of which must long remain unanswered; for others we have perhaps the data for their solution. W. H. B.

The volume which has been here reviewed, and which, as the abstract presented has shown, is so rich in facts, is only a preliminary report on the Geology of the State. Professor Whitney has nearly ready another, giving the systematic geology with all its details and general conclusions; and he proposes to follow this with one or two on the Economical Geology, Mining and Metallurgy, in which department a large amount of material has been

collected, and also by one on Physical Geography. In addition, the plan of the Survey, as we learn from the Preface, contemplates a second volume on Paleontology by Mr. Gabb, Dr. Leidy, Dr. Newberry and others; one on the Botany of the State, by Prof. W. H. Brewer; three or four on Zoology by Dr. Cooper, Mr. T. Gill, etc.; and one of Maps, Sections, etc.

This first volume on the Geology is beautiful as a work of art, both in its printing and in its numerous landscape and other illustrations, and well worthy of the rich State from which it emanates.

Up to the commencement of the current year the aggregate sum appropriated by the Legislature of the State for carrying on the work has been $95,000. In addition to this, $9,000 has been appropriated for publishing the results.

That this sum has been most economically used, the volumes bear ample testimony. This is less than $16,000 per year for field-work, salaries, and all expenses whatsoever, except those of publishing. With this sum a reconnoissance has been made of a territory larger than the combined areas of the three largest States east of the Mississippi river, portions of it over most inhospitable regions; considerable areas have been examined in some detail; the main feature of the geology of a region embracing at least 200,000 square miles has been demonstrated, and the key furnished for future work over the immense region west of the Rocky Mountains; and, aside from the practical questions of the greatest moment, most important contributions have been made to many departments of science.

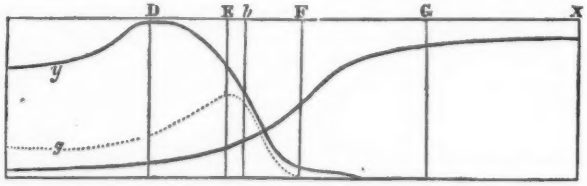
We not only earnestly hope but trust that the Survey with its publications may be continued to a satisfactory completion. It surely will be if the Legislators of the State view the work with the interest that is felt by the world outside. J. D. D.

ART. XLIV.—*On the Green tint produced by mixing blue and yellow powders;* by O. N. ROOD, Prof. of Physics in Columbia College.

IT is known to every one, that the mechanical mixture of yellow and blue powders, ("water or oil colors,") produces a more or less lively green. This fact, with others similar in nature, was formerly used by some physicists in support of the view that there are only three primary colors—red, yellow and blue,—and that the other tints of the spectrum are formed by a mixture of these three in certain proportions. Helmholtz has, however, shown that the mixture of the blue and yellow of the *spectrum* produces not green, but *white light.* Similarly it is

now known that if a circular disc be painted with alternate blue and yellow sectors, and then be caused to rotate rapidly, the resultant tint will be gray, or reddish gray, but not green. Helmholtz has accounted for the production of a green color when blue and yellow pigments are mixed, in a manner like the following: Light reflected from a painted surface is of a two-fold kind: 1st, That which comes directly from the surfaces of the little atoms of colored powder; this will, in ordinary day-light, be white, and small in amount. 2nd, That light which penetrates through two or more atoms of the pigment, and is then reflected; this is always colored, and colored merely because in its passage through the atoms, certain rays have been absorbed. For example, the white light which penetrates through an atom of ultramarine, in this operation becomes deprived mainly of the red, orange, and yellow rays; the green, blue and violet rays being left comparatively unweakened. The particles of chrome-yellow, on the other hand, in the same process absorb the blue and violet rays, reflecting back the red, orange and green rays. Hence it will be seen that by the joint action of the ultramarine and chrome-yellow, all the rays of the spectrum are absorbed except the green; therefore green light alone is reflected back to the eye.

This theory I have lately tested with the aid of the spectroscope. Three strips of white paper, each $\frac{1}{10}$th of an inch in breadth, were painted respectively with chrome-yellow, artificial-ultramarine, and a mixture of these two pigments in such proportion as to produce a green. The strips were placed together before the slit of a spectroscope, illuminated by light from a white cloud, and their spectra compared with a normal spectrum from a strip of white paper. It was found that if the intensity of the tints of the normal spectrum be represented by the rect-



angle BX, the spectra from the yellow, green, and blue papers, will be approximately represented by the areas contained in the curves y, g and B. Mere inspection shows that the spectrum from the green paper is made up of those rays which are common to both of the other spectra, its maximum being between the fixed lines E and b. Inspection also of the curves given by the chrome-yellow and ultramarine, show that both are rather

deficient in the green element, and therefore comparatively unfit to produce a bright green by mixture.

A disc was now painted with alternate blue and yellow sectors, the same materials being used; when it was caused to revolve rapidly the resultant tint presented to the naked eye was slightly reddish grey. Next the same disc was made to rotate before the slit of the spectroscope: prismatic analysis showed that its spectrum was totally different from the spectrum furnished by the green paper: it approximated to the normal spectrum, being in fact the sum of the spectra *y* and B in the diagram; there was, however, a rather dark space between the fixed lines *b* and F. This may account for the fact that the revolving disc viewed by the naked eye appeared slightly reddish, instead of pure grey.

It will be seen, then, that the results of spectral analysis account for this singular phenomenon in all its details.

It would be equally easy to account for the fact, that much more brilliant greens are produced by mechanically mixing those yellow and blue pigments, which are, one or both, originally slightly greenish in tint.

New York, March 10, 1866.

ART. XLV.—*A method of Estimating and Correcting the Error caused by the unequal length of the Calendar Months, in reducing Observations of Temperature;* by E. L. DE FOREST, of Watertown, Conn.

THE mean daily temperatures throughout the year at any given place may be represented by ordinates to the curve whose equation is

$$y=A_0+A_1 \sin(x+E_1)+A_2 \sin(2x+E_2)+A_3 \sin(3x+E_3)+\&c.$$

the length of the year being 360° measured on the axis of x. The values of the first twelve constants may be found approximately from the observed monthly means. But when these means are made use of as if the calendar months were all equal in length, an error will be introduced into the equation.

The amount of this error has been considerably underrated by Prof. J. D. Everett, of King's College, Nova Scotia, in an article which appeared in this Journal for January, 1863. Supposing apparently that because February is the month which differs most from the other months in length, it must therefore be the immediate cause of the greater portion of the error, Prof. Everett interchanged several days between it and the adjacent months January and March, and found that for Edinburg a dif-

ference of seven days in the length of February causes only a difference of ·03 in the mean annual temperature A_0, and 18′ or about one-third of a day in the "date" E_1; while the difference between giving February 29, and 31 days, does not affect either the mean temperature or the "amplitude" A_1, to two places of decimals, and only affects "date" by about $\frac{1}{16}$ of a day. This result indicated an error small enough to be disregarded. But the fact is that the unequal length of the months affects not only February but all the other months, and occasions an error several times greater than this, as will appear hereafter.

The length of the year being taken at $365\frac{1}{4}$ days, one twelfth part of it will be $30\frac{7}{16}$ days, which for convenience's sake I will call a *mean month*. I propose to show how to find the mean temperatures of the mean months, and to derive from them the equation of the curve, which will thus be corrected for the inequality of the months; then by comparing such equations with uncorrected ones found by using calendar months only, the real amount of the errors in question will become known.

Reckoning from the beginning of January, and allowing $28\frac{1}{4}$ days to the calendar month of February, we shall find that

The	2nd	mean	month	begins	$\frac{9}{16}$	days	before	February begins.
"	3rd	"	"	"	$1\frac{5}{8}$	days	after	March begins.
"	4th	"	"	"	$1\frac{1}{16}$	"	"	April "
"	5th	"	"	"	$1\frac{1}{2}$	"	"	May "
"	6th	"	"	"	$\frac{15}{16}$	"	"	June "
"	7th	"	"	"	$1\frac{3}{8}$	"	"	July "
"	8th	"	"	"	$\frac{13}{16}$	"	"	August "
"	9th	"	"	"	$\frac{1}{4}$	"	"	September "
"	10th	"	"	"	$\frac{11}{16}$	"	"	October "
"	11th	"	"	"	$\frac{1}{8}$	"	"	November "
"	12th	"	"	"	$\frac{9}{16}$	"	"	December "

If we have the daily mean temperatures at a given place tabulated for every day in the year, as in the table for Greenwich given by Prof. Loomis in his remarks appended to Prof. Everett's article, it will be easy to find the means for the mean months. For instance, in the month of April the sum of all the daily means at Greenwich is 1387·1. From this must be subtracted 43·6 which is the daily mean for April 1st, and 2·76 which is one-sixteenth of the mean for April 2nd; then there must be added 50·0 the mean for May 1st, and 25·25 which is one-half the mean for May 2nd. This gives 1415·99 as the sum of all the daily means for the fourth mean month, and dividing by $30\frac{7}{16}$ we get 46·52 for its mean temperature.

The mean temperatures for the calendar months at Greenwich are, from 43 years' observations,

36·59	46·24	61·77	49·94
38·55	52·66	61·05	43·25
41·33	58·95	56·48	39·33

and the mean of them all, or the annual mean, is 48·863. In the manner just explained I have found that the means for mean months are

36·58	46·52	61·80	49·84
38·62	53·12	60·99	43·20
41·47	59·13	56·39	39·28

and the annual mean is 48·912. The mean months make the annual mean greater by ·049 than the calendar months do. We evidently cannot infer that the mean of the monthly means will be equal to the annual mean unless the months are all of equal length.

To find the equation of the curve for Greenwich I have followed the method given by Prof. Everett, determining first the equation which expresses the series of monthly means, and then multiplying the "amplitudes" A_1, A_2, A_3, &c., by the ratios $\frac{\text{arc } 15^\circ}{\sin 15^\circ}$, $\frac{\text{arc } 30^\circ}{\sin 30^\circ}$, $\frac{\text{arc } 45^\circ}{\sin 45^\circ}$, &c., respectively, and substituting $x-15^\circ$ instead of x, so as to place the origin of coördinates at the beginning of January. Finally, I have transformed the equation from

$$y=A_0+A_1\sin(x+E_1)+A_2\sin(2x+E_2)+A_3\sin(3x+E_3)+\text{ &c.},$$

into the form

$$y=A_0\pm A_1\sin(x-e_1)\pm A_2\sin 2(x-e_2)\pm A_3\sin 3(x-e_3)\pm \text{ &c.}$$

This is readily done, because when E_n is greater than 180° we shall have

$$\sin(nx+E_n)=\sin n[x-\tfrac{1}{n}(360^\circ-E_n)],$$

and when E_n is less than 180° we shall have

$$\sin(nx+E_n)=-\sin n[x-\tfrac{1}{n}(180^\circ-E_n)].$$

The advantage of this transformation is that the equation will show the "date of phase" at a glance, the arc e_1 being the measure of the time from the beginning of the year to the date when the term $A_1\sin(x-e_1)$ first becomes zero. In general, the arc e_n expresses the time between the beginning of the year and the first zero-point of the term $A_n\sin n(x-e_n)$. Furthermore, the positive or negative sign prefixed to any term will show whether the value of that term is increasing or diminishing at the point where it first becomes zero; in other words, to borrow a phrase from Astronomy, the sign will show whether the first *node* is an *ascending* or a *descending* one.

The means for the calendar months give the following as the final equation of daily temperatures at Greenwich.

$$y=48\cdot86$$
$$+12\cdot59\sin(x-112^\circ\,38')-\cdot85\sin 2(x-76^\circ\,1')+\cdot17\sin 3(x-23^\circ\,40')$$
$$+\cdot28\sin 4(x-40^\circ\,42')-\cdot26\sin 5(x-0^\circ\,39')-\cdot23\sin 6x.$$

But the means for mean months make the equation stand thus:

$$y = 48{\cdot}91 + 12{\cdot}60\sin(x - 111^\circ\,51') - {\cdot}80\sin 2(x - 75^\circ\,30') + {\cdot}16\sin 3(x - 23^\circ\,28') + {\cdot}28\sin 4(x - 40^\circ\,33') + {\cdot}25\sin 5(x - 35^\circ\,37') - {\cdot}24\sin 6x.$$

It will be seen that these two equations differ somewhat in almost every term, but the most important difference is in the arc e_1 which is diminished by 47′ when derived from mean months, making the "date of phase" occur apparently more than three-quarters of a day earlier. The real difference of date is not quite so large, and is in the contrary direction; because the time elapsed from the beginning of the year to the date when the term $A_1 \sin(x - e_1)$ becomes zero is estimated differently in the two equations. In the first one each of the months is supposed to correspond to 30° of arc; the months of January, February, and March will occupy 90°, and the remaining arc $112^\circ\,38' - 90^\circ = 22^\circ\,38'$ will represent a period of time to be found by the proportion

$$30^\circ : 22^\circ\,38' = 30 \text{ days} : 22{\cdot}63 \text{ days},$$

which gives the date required, reckoning from the beginning of April.

In the second equation the arc e_1 will represent a period of time to be found by the proportion

$$360^\circ : 111^\circ\,51' = 365\tfrac{1}{4} \text{ days} : 113{\cdot}48 \text{ days}.$$

But the months January, February and March occupy $31 + 28\frac{1}{4} + 31 = 90\frac{1}{4}$ days; so that the time from the beginning of April to the required epoch is $113{\cdot}48 - 90{\cdot}25 = 23{\cdot}23$ days. Thus the use of mean months shows that the "date of phase" is really three-fifths of a day later than it is found to be when only calendar months are employed.

The date we have been considering is the one which occurs in spring; but if we take the autumnal one instead, then according to the method of calendar months the arc between the beginning of October and the required date will be 22° 38′ just as in April, and the time corresponding to it will be found by the proportion

$$30^\circ : 22^\circ\,38' = 31 \text{ days} : 23{\cdot}39 \text{ days}.$$

On the other hand, by the method of mean months the time from the autumnal date till the end of the year will be found by subtracting 113·48 days from $\frac{1}{2}$ of $365\frac{1}{4}$ days, which gives 69·14 days. But the last three months of the year contain $31 + 30 + 31 = 92$ days; so that the time from the beginning of October to the date required is $92 - 69{\cdot}14 = 22{\cdot}86$ days. The autumnal "date of phase" then really occurs a little more than half a day earlier than the method of calendar months would make it appear.

To determine whether such results are owing to any peculiar-

ity in the climate of Greenwich, I have computed the equations for three other places whose climates are widely different, taking from the Army Meteorological Register the monthly means derived from 33 years' observations at Fort Columbus, New York Harbor, from 1822 to 1854, and those derived from 36 years' observations at Fort Snelling (St. Paul), Minnesota, and from 28 years' observations at Fort Moultrie, Charleston Harbor, South Carolina, from 1823 to 1854. But not having access to any concise table of daily temperatures for every day in the year at those places, I have been led to adopt the following method for finding the means for mean months directly from the means for calendar months, avoiding the use of daily means altogether.

We may assume that the portion of the curve which belongs to any three consecutive calendar months will coincide very closely with a curve of the 2nd degree whose equation is

$$y=\mathrm{A}+\mathrm{B}x+\mathrm{C}x^2.$$

If we take the middle ordinate of the middle month as the axis of Y, and let n_1 n_2 n_3 represent the number of days in each month respectively, their mean temperatures will be

$$m_1=\frac{1}{n_1}\int_{-\frac{1}{2}n_2-n_1}^{-\frac{1}{2}n_2} y\,dx=\mathrm{A}-\frac{1}{2}\mathrm{B}(n_1+n_2)+\frac{1}{12}\mathrm{C}(4n_1^2+6n_1n_2+3n_2^2),$$

$$m_2=\frac{1}{n_2}\int_{-\frac{1}{2}n_2}^{+\frac{1}{2}n_2} y\,dx=\mathrm{A}+\frac{1}{12}\mathrm{C}n_2^2,$$

$$m_3=\frac{1}{n_3}\int_{\frac{1}{2}n_2}^{\frac{1}{2}n_2+n_3} y\,dx=\mathrm{A}+\frac{1}{2}\mathrm{B}(n_2+n_3)+\frac{1}{12}\mathrm{C}(4n_3^2+6n_2n_3+3n_2^2).$$

These three equations enable us to determine the three constants A, B, C, as follows:

$$\mathrm{A}=m_2-\frac{n_2^2}{4}\left(\frac{(n_2+n_3)m_1+(n_1+n_2)m_3-(n_1+2n_2+n_3)m_2}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)}\right),$$

$$\mathrm{B}=\frac{(n_2+n_3)(n_2+2n_3)(m_2-m_1)+(n_1+n_2)(n_2+2n_1)(m_3-m_2)}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)},$$

$$\mathrm{C}=3\left(\frac{(n_2+n_3)m_1+(n_1+n_2)m_3-(n_1+2n_2+n_3)m_2}{(n_1+n_2)(n_2+n_3)(n_1+n_2+n_3)}\right).$$

Now let x_1 represent the time, in days, from the middle point of the middle month to that of the corresponding mean month, and let c represent the number of days in the mean month; then its mean temperature will be

$$M_2=\frac{1}{c}\int_{x_1-\frac{1}{2}c}^{x_1+\frac{1}{2}c} y\,dx=A+Bx_1+C\left(x_1^2+\frac{c^2}{12}\right).$$

Substituting in this expression for M_2 the values of A, B, C, already found, and reducing, and putting h for the time in days from the beginning of the middle calendar month to the beginning of the mean month, h being negative when the latter begins earlier than the former, and employing H, K, L, as auxiliary letters, we obtain the following series of equations by which to find the value of M_2:

$$x_1=h+\frac{1}{2}(c-n_2),$$

$$H=(n_2+c)(n_2-c)-12x_1^2,$$

$$K=\frac{H+4x_1(n_2+2n_3)}{4(n_1+n_2)(n_1+n_2+n_3)},$$

$$L=\frac{H-4x_1(n_2+2n_1)}{4(n_2+n_3)(n_1+n_2+n_3)},$$

$$M_2=m_2+(K+L)m_2-Km_1-Lm_3.$$

Now taking those values for n_1, n_2, n_3, and h, which are appropriate for each of the twelve months in succession, allowing $28\frac{1}{4}$ days to February, and giving c its value of $30\frac{7}{15}$ days, we shall find that

$$\begin{aligned}
M_1 &= m_1 + \cdot0036\,m_1 + \cdot0029\,m_{12} - \cdot0065\,m_2\\
M_2 &= m_2 - \cdot0123\,m_2 - \cdot0028\,m_1 + \cdot0151\,m_3\\
M_3 &= m_3 + \cdot0027\,m_3 - \cdot0237\,m_2 + \cdot0210\,m_4\\
M_4 &= m_4 - \cdot0041\,m_4 - \cdot0190\,m_3 + \cdot0231\,m_5\\
M_5 &= m_5 + \cdot0015\,m_5 - \cdot0207\,m_4 + \cdot0192\,m_6\\
M_6 &= m_6 - \cdot0038\,m_6 - \cdot0171\,m_5 + \cdot0209\,m_7\\
M_7 &= m_7 + \cdot0025\,m_7 - \cdot0190\,m_6 + \cdot0165\,m_8\\
M_8 &= m_8 + \cdot0024\,m_8 - \cdot0098\,m_7 + \cdot0074\,m_9\\
M_9 &= m_9 - \cdot0026\,m_9 - \cdot0064\,m_8 + \cdot0090\,m_{10}\\
M_{10} &= m_{10} + \cdot0029\,m_{10} - \cdot0081\,m_9 + \cdot0052\,m_{11}\\
M_{11} &= m_{11} - \cdot0025\,m_{11} - \cdot0044\,m_{10} + \cdot0069\,m_{12}\\
M_{12} &= m_{12} + \cdot0032\,m_{12} - \cdot0062\,m_{11} + \cdot0030\,m_1
\end{aligned}$$

These twelve equations make it easy to compute the mean temperature, M_n, of any one of the twelve mean months when the mean temperatures, m_{n-1}, m_n, m_{n+1}, of the three nearest calendar months are known. And it may be remarked that this method of reduction is applicable not only to temperatures, but to observations of rain-fall, or any other phenomena where monthly means are employed. As a test of its accuracy I have used it for computing the equation of the curve for Greenwich, and compared the result with that obtained by the help of the table of daily means. It gives the means for mean months thus:

36·59	46·49	61·81	49·85
38·60	53·13	61·01	43·19
41·50	59·11	56·39	39·30

Taking as a standard the means previously obtained from the table of daily means, it will be seen that these approximate means for mean months differ from the true ones by only a maximum error of ·03 and an average error of ·016. They give for the equation of the curve

$$y=48\cdot91 + 12\cdot60\sin(x-111^\circ\,52') - \cdot81\sin 2(x-75^\circ\,35') + \cdot16\sin 3(x-24^\circ\,3') + \cdot28\sin 4(x-40^\circ\,47') - \cdot26\sin 5(x-0^\circ\,50') - \cdot23\sin 6x,$$

and this result will be found to agree substantially with that previously deduced from the true means for mean months, except that e_1 is larger by 0° 1′; there are also some variations in the succeeding terms of the equation, but they are of little consequence because the coefficients are small.

I have computed the mean temperatures for mean months at New York, St. Paul, and Charleston by the same method of reduction. The observed means for calendar months at New York are

30·18	48·65	74·83	54·56
30·44	59·30	73·16	43·32
38·28	68·30	65·78	33·52

and the approximate means for mean months are found to be

30·19	49·09	74·93	54·41
30·56	59·69	73·09	43·20
38·68	68·59	65·63	33·45

The resulting equation of daily temperatures is for calendar months

$$y=51\cdot69 + 22\cdot75\sin(x-113^\circ\,28') + \cdot53\sin 2(x-3^\circ\,37') - \cdot43\sin 3(x-5^\circ) - \cdot44\sin 4(x-39^\circ\,26') - \cdot17\sin 5(x-34^\circ\,31') + \cdot40\sin 6x,$$

and for mean months

$$y=51\cdot79 + 22\cdot75\sin(x-112^\circ\,42') + \cdot48\sin 2(x-5^\circ\,52') - \cdot45\sin 3(x-4^\circ\,17') - \cdot44\sin 4(x-38^\circ\,35') - \cdot18\sin 5(x-33^\circ\,37') + \cdot41\sin 6x,$$

showing an increase of ·10 in the annual mean A_0 and showing a decrease of 0° 46′ in the arc e_1; this difference of arc being almost exactly the same for New York as it is for Greenwich.

Again, the means for calendar months at St. Paul are

13·76	46·34	73·40	47·15
17·57	58·97	70·05	31·67
31·41	68·46	58·86	16·89

and for mean months they are

13·74	46·92	73·44	46·97
17·79	59·41	69·93	31·50
32·05	68·73	58·68	16·79

The equation of the curve is found from calendar months to be

$$y=44\cdot54 +29\cdot86\sin(x-105^\circ\,27')+1\cdot82\sin 2(x-55^\circ\,28')+\cdot91\sin 3(x-45^\circ\,23') +\cdot88\sin 4(x-0^\circ\,24')-\cdot74\sin 5(x-28^\circ\,58')+\cdot21\sin 6x,$$

and from mean months it is

$$y=44\cdot66 +29\cdot86\sin(x-104^\circ\,41')+1\cdot93\sin 2(x-55^\circ\,26')+\cdot96\sin 3(x-45^\circ\,33') -\cdot84\sin 4(x-44^\circ\,54')-\cdot77\sin 5(x-28^\circ\,40')+\cdot22\sin 6x.$$

Thus the corrected curve increases the annual mean A_0 by ·12 and diminishes the arc e_1 by 0° 46′.

The Charleston observations give the following means for calendar months:

50·36	65·44	81·72	67·88
52·41	73·42	80·94	59·56
58·68	79·01	76·89	52·51

and reduced to mean months they are

50·35	65·75	81·76	67·76
52·51	73·69	80·90	59·47
58·97	79·16	76·78	52·46

The equation of the curve is for calendar months

$$y=66\cdot57 +16\cdot07\sin(x-109^\circ\,21')+\cdot86\sin 2(x-34^\circ\,24')-\cdot15\sin 3(x-55^\circ) +\cdot29\sin 4(x-44^\circ\,10')+\cdot09\sin 5(x-7^\circ\,1')+\cdot32\sin 6x,$$

and for mean months it is

$$y=66\cdot63 +16\cdot07\sin(x-108^\circ\,35')+\cdot88\sin 2(x-35^\circ\,41')-\cdot13\sin 3(x-54^\circ\,6') +\cdot31\sin 4(x-44^\circ\,17')+\cdot09\sin 5(x-5^\circ\,22')+\cdot33\sin 6x.$$

Here the annual mean A_0 is increased by ·06, and the arc e_1 diminished by 0° 46′.

The diminution of e_1 is therefore almost exactly the same at Greenwich, New York, St. Paul, and Charleston. The coefficient A_1 is nowhere sensibly altered by changing from calendar to mean months. It will be found that the increase in the annual mean, A_0, bears a nearly constant ratio to A_1. This ratio is ·00404 for Greenwich, ·00436 for New York, ·00396 for St. Paul, and ·00384 for Charleston. The mean of the four ratios is ·00405. It may therefore be inferred that if we have for the climate of any place the equation

$$y=A_0+A_1\sin(x-e_1)$$

obtained on the supposition that the calendar months are of

equal length, it will be corrected for the inequality of the months if we take

$$y = A_0 + \cdot 0041\ A_1 + A_1 \sin (x - e_1 - 0° 46').$$

This rule may be expected to hold good for extra-tropical climates generally.

The corrections due to the remaining constants, A_2, e_2, A_3, e_3, &c., seem to be dependent on local peculiarities of temperature, and not subject to any simple and general laws.

The utility of any system of representing climates by equations of curves must of course depend much upon the accuracy of the representation. Enough has been done to show that equations derived from monthly means will fail to determine the annual mean and the "date of phase" with any considerable degree of accuracy unless allowance is made for the inequality of the months. It is probably safe to assert that the method of mean months will give results of a higher degree of exactitude than any other method which does not employ more than twelve temperatures to determine the values of the constants.

Dec. 1865.

ART. XLVI.—*On the comparative composition of some Recent Shells, a Silurian Fossil Shell and a Carboniferous Shell Limestone;* by Prof. HOW, D.C.L., University of King's College, Windsor, Nova Scotia.

THE analyses of shells here given were originally made as part of an investigation which it was proposed to institute into the composition of various recent as compared with that of well preserved fossil molluscous shells. The enquiry was set on foot by Dr. Lyon Playfair, at that time Professor of Chemistry in the Museum of Economic Geology in London, where I was engaged in the British Admiralty Enquiry on Coals suited to the steam navy. It was not, I think, prosecuted very far, and I have never heard of the publication of any results of the experiments made. I now communicate the analyses which, with the exception of one or two determinations, I made myself, thinking they have sufficient interest for publication, and that they may perhaps induce some one else to carry on such an investigation as that of which they formed part. With these analyses I give the composition of a shell limestone.

The recent shells were obtained in the London markets and were scrupulously cleaned from their inhabitants. When the animal matter could not be entirely removed in the fresh state it was allowed to putrefy till it could be separated. The Silurian fossil shell was obtained from the collection in the British

Museum. The limestone is Nova Scotian. The first analysis is that of the shell of the Periwinkle (*Litorina litorea*). The results obtained were these:

	I.	II.	Mean.
Lime,	54·551	54·378	54·464
Carbonic acid,	42·821	.....	42·821
Sulphuric acid,	0·282	0·283	0·282
Organic matter,[a]	2·010	2·040	2·025
Sand and silica,	0·164	....	0·164
Phosphoric acid,	0·001	....	0·001
			99·757

[a] Containing 0·07 nitrogen.

The analysis of the shell of the oyster (*Ostrea edulis*) gave,

	I.	II.
Lime,	53·368	....
Carbonic acid,	40·600	....
Sulphuric acid,	0·809	0·800
Organic matter,[b]	3·478	3·170
Sand and silica,	1·495	....
Phosphoric acid,	0·106	....
Sesquioxyd of iron,	0·039	....
	99·895	

[b] Containing 0·155 nitrogen.

On comparing these numbers with the preceding, we observe a great increase in the amounts of sulphuric acid, phosphoric acid, and, especially in organic matter, in which, moreover, the nitrogen is much more abundant.

The analysis of the shell of the Mussel (*Mytilus edulis*) gave:

Lime,	52·862
Carbonic acid,	41·020
Sulphuric acid,	·350
Organic matter,	5·020
Sand and silica,	·208
Phosphoric acid,	·048
Sesquioxyd of iron,	·036
	99·640

On comparing with the foregoing we observe again increased organic matter, while sulphuric and phosphoric acids are much as in Litorina.

The Silurian fossil was *Leptæna depressa*. It gave,

Lime,	54·02
Carbonic acid,	41·79
Sulphuric acid,	0·55
Organic matter,	1·61
Silica,	1·58
Phosphoric acid,	0·14
Sesquioxyd of iron,	0·26
	99·95

The resemblance here shown between this brachiopod shell and that of the univalve Litorina is very great. We should rather

have expected similarity in this respect between the brachiopod *Leptæna* and the *Conchifers*, *Ostrea* and *Mytilus*, all three having the two-valved structure. The presence of a much larger amount of organic matter in the two latter than in the univalve Litorina seems to show that the relative abundance of animal substance in the shell is essentially connected with the two-valved structure; if so, we must probably conclude that the Leptæna had been mineralized at the expense of a considerable amount of this material; in other respects it closely resembles the recent molluscous shells. The fossil occurs in limestones, slates, schists, and sandstones, but I have no record as to the matrix of the specimen analyzed.

The carboniferous limestone compared with the foregoing is a specimen of the Lower Carboniferous marine formation of Windsor, N. S.; it is made up to a great extent of shells among which brachiopods are abundant. It gave on analysis:

Carbonate of lime,	97·64
Carbonate of magnesia,	1·10
Sesquioxyd of iron,	0·07
Clay, sand, and silica,	0·68
Phosphoric acid,	trace
	99·49

Here we may note the absence of organic matter and the addition of a little magnesia, introduced, no doubt, by the actions of sea-water. Had the investigation, of which the foregoing will indicate to some extent the design, been carried on, many interesting results would no doubt have been obtained.

ART. XLVII.—*Experiments on the Production of Organisms in Closed Vessels;* by GEORGE CHILD, M.D.[1]

THE researches, an account of which is contained in the following paper, are in continuation of those which, through the kindness of Prof. Phillips, I had the honor of communicating to the Royal Society in May last, and of which an abstract appeared in the 'Proceedings' for June 16, 1864. The former series of experiments did not pretend to be, in any respect, complete. Those which I am now about to describe will, I hope, be considered to be more so in regard to one main subject of the inquiry; but they also suggest further researches upon some collateral branches of it, which I hope to find time and opportunity to prosecute. In the former series I experimented with animal substances mixed with water and enclosed in glass bulbs

[1] From the Proceedings of the Royal Society for April 27, 1865, p. 178.

in atmospheres either of common air passed through red hot tubes or of various gases, and the result at which I arrived was that where oxygen was present organisms of a low type were produced, but not so where that gas was not present. Thus, whatever the gas employed, where the substance was not boiled, the organisms appeared; but in the instances in which the substance was boiled, they appeared where oxygen or common air was used, but not where nitrogen, hydrogen or carbonic acid was employed. One experiment only appeared to have produced a result which could not be reconciled with the rest, viz. in which some meat and water had been boiled and sealed up in an atmosphere of nitrogen. In this, some organisms were found; but so completely was this result unlike that found in the whole of the rest of the series, that I felt convinced that some error must have been made in the experiment itself.

The experiments now to be described have a narrower range than the others. With the exception of a few, which were mere repetitions of the experiments of nitrogen just referred to, and which were undertaken solely with the view of seeing whether the experiment just mentioned were correct or not, they are confined to the single object of observing whether or not organisms are found in close vessels containing vegetable matter and water sealed up in an atmosphere of common air previously passed through an efficient heating apparatus.

In these experiments I have adopted some slight modifications of the apparatus used in the former ones. That now employed consists of a porcelain tube, the central part of which is filled with roughly pounded porcelain; one end is connected with a gas-holder, and to the other the bulb is joined which contains the substance to be experimented upon. The bulb has two narrow necks or tubes, each of which is drawn out before the experiment begins, so as to be easily sealed by the lamp; one neck is connected with the porcelain tube, as already stated, by means of an india-rubber cork, and the other is bent down and inserted into a vessel containing sulphuric acid. The central part of the porcelain tube is heated by means of a furnace, and when it has attained a vivid red heat the bulb is joined on, the end of the porcelain tube which projects from the furnace being made thoroughly hot immediately before the cork is inserted, the cork itself being taken out of boiling water, and the neck of the bulb being also heated with a spirit-lamp immediately before it is inserted into the cork. A stream of air is now passed through the apparatus by means of the gas-holder, and bubbles through the sulphuric acid at the other end. The substance in the bulb is then boiled for ten or fifteen minutes, the lamp withdrawn, and the bulb allowed to cool while the stream of air is still passing through the porcelain tube, maintained

during the whole time at a vivid red heat. When the bulb is quite cool, the necks are sealed by means of a lamp. The advantage gained by means of this apparatus is that there is only one joint the perfection of which in any degree affects the success of the experiment, and that joint it is easy to make sure. The porcelain tube also being, for a considerable part of its length, filled with small fragments of porcelain, all heated up to redness, easily ensures that every particle of air admitted to the bulb shall be thoroughly heated. A precisely similar arrangement was used for the nitrogen experiments, substituting a glass combustion-tube filled with copper turnings for the porcelain tube, and a piece of india-rubber tubing for the india-rubber cork. The copper-oxyd was reduced by means of a stream of hydrogen when necessary between one experiment and the next.

A single experiment was tried on May 18, 1864, using apparatus similar to that employed in the experiments of the previous year.

Some pea-meal infused in water was boiled in a stream of heated air, allowed to cool, and then sealed and put by. I was then prevented from resuming my experiments for several weeks.

Then several experiments were made with nitrogen, for the purpose of confirming or correcting the nitrogen experiment of the previous year. Into the particulars of these I need not now enter, further than to say that seven experiments were tried with various infusions. Five of them were afterwards examined, and in no case were any organisms found, thus confirming me in the opinion already expressed upon that experiment. The series with which I am now concerned began on July 18.

VII. July 18.—Hay infused in water three hours, then filtered and boiled 12 minutes in a stream of heated air, and sealed up as above described.

VIII. July 18.—A similar experiment: boiled 10½ minutes.

IX. July 22.—Toppings, *i. e.* coarse flour infused in cold water 3 hours, filtered and boiled 10 minutes in a similar stream of air.

X. July 22.—A similar experiment: boiled also 10 minutes.

XI. July 25.—A similar experiment: boiled 12 minutes.

XII. July 25.—A similar experiment: boiled 10 minutes.

XIII. July 28.—Some sage-leaves bruised and infused in lukewarm water previously boiled. Allowed to stand 15 hours, filtered, and the clear fluid boiled 10 minutes in a stream of heated air, as in the other cases, and sealed up.

XIV. July 28.—A similar experiment: boiled 7 minutes.

XV. July 29.—A similar infusion of celery, allowed to stand 12½ hours, and treated as the last: boiled 12 minutes.

The bulb used in this last experiment was of a different form, which I have found much more convenient, and have always

employed in my subsequent experiments, which are presently to be described. (It is represented in figure 1.)

The examination of the above series of experiments took place partly on Sept. 19, when Dr. Beale kindly visited me at Oxford, in order to give me his valuable assistance, and partly at Dr. Beale's home in London, on Nov. 16, 1864.

Exp. of May 18.—Viz. pea-meal and water. In this were found small organisms moving, as given by Dr. Beale in the accompanying drawing, figure 2. Their size was extremely minute, as they are here drawn as they appeared under a power of 1700.

Exp. VII.—Hay + water + heated air. Some large dumbbell-shaped crystals and a few bacteriums, very minute, but not so small as in the former case (fig. 3).

Exp. VIII.—The pair experiment to VII. Similar crystals, and organisms also similar, but larger.

Exp. IX.—Coarse flour + water + heated air. The result of this experiment was unsatisfactory, and serves well to show the difficulty of a decision upon these questions.

Even with the high powers above named, we were unable to be certain of our result in this and several following cases. There were no organisms distinctly recognizable as such, but many minute round spore-like bodies moving about the field.

Exp. X.—The fellow experiment to the last, and similarly unsatisfactory.

Exp. XIII.—Sage + water + heated air. A few crystals were seen, but no organisms.

Exp. XV.—Celery + water + heated air. Some prismatic crystals; no organisms.

It was resolved to leave the rest of these experiments till a longer time should have elapsed since the vessels were closed. The examination was accordingly resumed Nov. 16.

Exp. XII.—Coarse flour + water + heated air, contained some indeterminate granular matter, and some few bodies which might be dead bacteriums, but nothing that could safely be considered as such.

Exp. XI.—The fellow experiment to XII, and equally without result.

Exp. XIV.—Sage + water + heated air, gave also no definite result.

Now, omitting altogether the nitrogen experiments, seven in number, we have here a series of ten experiments instituted with a view of showing whether organisms can be produced in vegetable infusions within closed vessels supplied with heated air. In my desire to try a variety of substances I took almost

anything which my garden afforded, and in this way probably my selection of sage and celery may have been a bad one, as the aromatic ingredients of these plants may be supposed to influence the result of the experiment, especially as in a close vessel any volatile oil would be retained. If, therefore, the three experiments with these substances be eliminated, there remain seven experiments, one with pea-meal, two with hay, and four with coarse flour. Of these, five were examined on Sept. 19, and in three (viz. the pea-meal and the two hay experiments) the vessels were found to contain moving organisms. In two (those performed with coarse flour) none were found, and in the remaining two, examined on Nov. 16, also none were found.

In the meantime, when, from several of the above experiments having produced negative results, I looked upon the series as inconclusive, I instituted a fresh series of twelve experiments in the end of September, as follows.

The apparatus employed was the same as that used in the last series, except that I had some large double bulbs made for the present series. In other respects the process was the same as before.

Exp. I. Sept. 30.—Hay infused 3½ hours in water, filtered, and boiled 10 minutes in a stream of heated air—sealed up when cool.
Exp. II. Sept. 30.—Similar in all respects.
Exp. III. Oct. 1.—Similar.
Exp. IV. Oct. 1.—Similar.
Exp. V. Oct. 5.—Flour infused in warm water 3½ hours and filtered: boiled 11 minutes, as before, and sealed.
Exp. VI. Oct. 5.—Similar: boiled 10 minutes.
Exp. VII. Oct. 5.—A similar infusion infused 6½ hours, not filtered; boiled 10 minutes.
Exp. VIII. Oct. 5.—Similar.
Exp. IX. Oct. 7.—Flour infused 3½ hours, not filtered: boiled 10 minutes in a stream of oxygen, and sealed as before.
Exp. X. Oct. 7.—Similar: boiled 10½ minutes.
Exp. XI. Oct. 7.—Flour infused 4½ hours and filtered: boiled 10 minutes in oxygen.
Exp. XII.—Similar.

On Oct. 8 this series of experiments was divided into two sets: [B], Nos. II, IV, VI, VIII, X, XII, were placed on a high shelf in my dining-room; the rest [A] in a hot closet, by the side of the cooking-stove, in the kitchen.

The object of the latter arrangement was to ensure the vessels being kept warm enough during the winter months; but the heat was, I have no doubt, too great. I saw the thermometer on more than one occasion over 140° Fahr., and have reason to believe that I did not see it at its highest. Moreover, the bulbs

here were almost wholly deprived of light. Thus, before opening the vessels, I had made up my mind that the results of the other half of the series were most to be depended upon. The temperature of the room in which they were probably never fell below 40° Fahr., and was generally between 50° and 60°.

The examination of the B division of this series took place at Dr. Beale's house, Feb. 7, 1865. The results were as follows:

Exp. IV.—Hay + water + heated air. A few bacteriums were found in active motion.

Exp. II.—Hay + water + heated air. Very large numbers of similar organisms were found.

Exp. VI.—Flour + water + heated air. Few were found as compared with the last, but still several in active motion.

Exp. XII.—Flour + water + oxygen. No organisms found.

Exp. VIII.—Flour + water + heated air (unfiltered). A good many bacteriums, similar to the others.

Exp. X.—Flour + water + oxygen (unfiltered). Some bacteriums, but not moving.

The other set of experiments was examined by me at Oxford on various evenings between Feb. 16 and March 8; but during some part of that time I possessed no object-glass of sufficient magnifying power to avoid all uncertainty in the results.

In both of them, viz. Nos. V and XI, I could find nothing like bacteriums. In the three others, viz. III, VII and IX, there were what appeared to me dead ones (but a dead bacterium is an object of which few persons who have seen many would think it very safe to be very positive), and in one only viz. No. I, an infusion of hay, were they numerous and moving. This I mention particularly, because the objects were very well seen, and moving actively in the first slide which I examined, and could be the better seen on account of the clearness of the fluid and the absence of granular matter; but upon examining several portions after the vessel had been open for a few minutes, though they continued to be seen in equally large numbers, all movement had ceased. They were examined with a $\frac{1}{25}$ object-glass of Messrs. Powell and Lealand. Now, if we omit from these two series of experiments those which I have already shown reason to distrust, we have, in all, seven in the first, and six in the second series, which seem fairly to test the question; and these having been examined by Dr. Beale, as well as myself, bacteriums were found and seen by both of us in three out of the first seven, and five out of the remaining six—in all, in eight.

Now, it may be asked, why the same or similar organisms were not found in the other cases, if the experiments were fairly tried? The answer is this, viz. that we do not know all the conditions under which they exist. It is pretty clear that they

appear more easily in some substances than in others. Thus, in the first series above described, it will be noticed that the four instances in which none were found were all those in which coarse flour was the substance used. In the remaining three, where pea-meal or hay were employed, there the bacteriums were seen. So also in the other series, the one case in which nothing was found, was a case in which flour was used, and in the remaining five the most numerous and distinct bacteriums were seen in the hay infusion. This may arise possibly from the fact that the infusion of flour is not so clear as the others, and always contains more granular matter; thus bacteriums are less easily distinguished in it: and, where doubtful, it is my practice to decide in the negative; that is to say, unless the bacteriums are clearly seen, I enumerate the experiment amongst those in which they are not found. Further, it is possible that in some infusions they may live and die sooner than in others, and in most of these experiments with flour there was a mass of indeterminate granular matter which might have contained the bodies of whole populations of bacteriums. Finally, it is quite possible that they might, if existing in small numbers, escape observation. Their minuteness is extreme, and observation of them far from easy. At any rate, positive evidence in a matter of this kind is of more value than negative; and the fact that in eight cases out of thirteen they have been seen, not by myself only, but also, by so accurate and practised a microscopist as Dr. Beale, is of more weight than our having been unable to discover them in the remaining five cases.

The question which now remains to be discussed is, how is it that the results above given so entirely disagree with those arrived at by Pasteur, and now, to a certain extent, vouched for by the Commission of the Academy of Sciences. I have observed all the precautions which Pasteur himself speaks of as "exaggerated," yet I have shown bacteriums to be produced exactly under the circumstances in which he asserts that they do not exist. I believe this discrepancy is very easily accounted for. Pasteur, in his memoir, speaks of examining his substances with a power of 350 diameters. Now my experience throughout has been that it is impossible to recognize these minute objects, with any degree of certainty, even with double that magnifying power. When once their existence on a slide is shown with a power of 1500 to 1700 diameters, it is quite possible afterwards to recognize the same object with a power of 750, but I have repeatedly failed to satisfy myself in the first instance with the latter power; and on the one occasion on which I enjoyed the use of an object-glass giving a power of 3000 diameters, I found the recognition of these very minute objects rendered very much more easy. On one occasion I tried

the effect of a power of 450 (not possessing one of 350), and found that all satisfactory investigation of such objects with such a power was impossible. Any person has only to examine the drawings which accompany this communication (in one particularly, that marked 2) in order to satisfy himself that to come to any conclusion as to the presence or absence of such objects as are there represented, with a magnifying power of little more than one-fifth linear measurement of that from which they are drawn, would be quite impossible. The Commission of the Academy of Sciences, which has not yet concluded its labors, has not, so far as its present report goes, concerned itself with the microscopy of the question; it has, in fact, confined itself to the dispute (which has almost become a personal one) between MM. Pasteur and Pouchet. It is worth noticing, that the fact so often referred to by writers on this subject, of the fluid in the closed vessels becoming cloudy or not as a test of the presence or absence of bacteriums, is not satisfactory; I have constantly predicted, from the cloudiness or clearness of an infusion, the presence or absence of bacteriums, and very frequently been mistaken—quite as often too in the former case as in the latter.

As to the conclusions which can be drawn from these experiments, I need say very few words. I can now have no doubt of the fact that "bacteriums" can be produced in hermetically-sealed vessels containing an infusion of organic matter, whether animal or vegetable, though supplied only with air passed through a red-hot tube with all necessary precautions for ensuring the thorough heating of every portion of it, and though the infusion itself be thoroughly boiled. But how far this fact affects the question of what is called "spontaneous generation" is quite another matter.

It seems clear that either (1) the germs of bacterium are capable of resisting the boiling temperature in a fluid, or (2) they are spontaneously generated, or (3) they are not "organisms" at all. I was myself somewhat inclined to the latter belief concerning them at one time; but some researches on which I am now engaged have gone far to convince me that they are really minute vegetable forms.

The choice therefore seems to remain between the other two conclusions. Upon these I will not venture a positive opinion, but remark only, that if it be true that "germs" can resist the boiling temperature in fluid, then both parties in the controversy are working upon a false principle, and neither Pouchet nor Pasteur is likely at present to solve the question of spontaneous generation. In truth, if Pasteur's facts are incorrect, the whole question is relegated to the domain of what the French Academy Commission calls "pure discussion;" and the one point which I claim to have established by their re-

searches is precisely that Mr. Pasteur's facts are inexact—not because his experiments were not most admirably performed, but simply because the magnifying power of his microscope was insufficient for the work to which he applied it. I desire to append two remarks to this paper. The first is, that the common *à priori* objection, which Mr. Pasteur so well expressed in his memoir, to heterogeny in all forms, viz. that it is a doctrine which has been gradually driven from all the higher forms of life in exact proportion as our observation of them has become more exact, until at last it has been compelled to take refuge in those lowest forms which we are almost or altogether unable to observe, is really of little or no force. Its cogency depends on analogy, and the analogy has no existence. It is quite equally to be expected *à priori* that if any forms of life are generated spontaneously, they will be the very lowest and simplest forms, and since these happen to be also the most minute, the objection loses its whole force. And it is also a thing to be expected that we should find only the lowest forms, the earliest, *i. e.* in the scale of existence, produced under the disadvantageous circumstances in which they must be placed in such experiments as those above detailed.

The other remark is this: that, so far as my present researches have led me, I cannot but look upon improvement in the construction of microscopes, and increase of their power, as the only way in which our means of investigation of such questions as the production of Bacterium is likely to be largely increased. The $\frac{1}{50}$ object-glass recently constructed by Messrs. Powell and Lealand, of which a notice has appeared in the Proceedings of the Royal Society, has already shown something like an appearance of structure in these minute objects, and leaves, I think, no doubt about their organic character.

ART. XLVIII.—*A word on the Origin of Life;* by JAMES D. DANA.

THE notion seems to be somewhat prevalent that if such experiments as those described in the preceding paper by Mr. Child really afford examples of spontaneous generation—that is, of the production of living organisms without the intervention of germs—they exemplify the process of the *first origin of life.* The claim made by Prof. H. J. Clark in the title of his recent work—"Mind in Nature, or the Origin of Life, and the mode of development of Animals"—to which we objected in the last number of this Journal, and which the body of the work endeavors to sustain, rests on no other basis. And his opinion of

the firmness of the foundation is shown by his taking one long step onward from this basis, as follows:[1]

The fact that the experiments[2] with the *sealed flasks* proved—if anything can be proved beyond the reach of change or improvement—that beings with motion, undoubted living beings, were produced when life could not possibly have existed previously, is *a sufficient* basis for the further assumption that still higher forms could arise from these. That is to say, if, under the conditions in the sealed flasks, living beings, either animals or plants,[3] of the lowest degree, arise, there is nothing illogical in assuming that, from these lowly organized, *animate* bodies, somewhat higher and more complicated beings may originate.

Now in the experiments referred to, and all of similar character, the experimenter starts with organic matter, either vegetable or animal. Allowing, then, that there are no germs present to breed such low organisms, the results are only examples of life from life; and to the question, what is the origin of life, they reply—*life*. For without some *pre-existing* plant or animal to afford the hay, or flour, or muscle, etc., there could have come none of the plants or animals bred by the alleged spontaneous generation. The world of such "creationists" would therefore have ever remained lifeless. Consequently, not the first stone is laid by these and like experimenters toward bridging over the interval between the inorganic and organic world; not the first step is taken into the yet dark regions back of the existence of life on the globe.

The organic matter operated upon is in one sense dead; that is, the organism as a whole has not its living functions. But still it originated through life; and, moreover, the particles in the fibre of hay or muscle are held together, or remain as they are, in virtue of the forces which, in the processes of life, formed it; just as the particles of a drop of water are retained as they are by the forces—far inferior in kind and amount—which made the combination water. When the decomposition of the material begins, and the forces are thus disturbed, then the moving things, claimed to be a spontaneous generation, make their appearance. From the compound *of high order* in the vegetable or animal kingdom—of high order no doubt chemically as well as vitally—comes the *lowest* in the vegetable kingdom, a cellular plant consisting of one or a few cellules, or perhaps an equally low animal organism.

[1] On page 26. We have already expressed our high opinion of the microscopical investigations by Prof. Clark, which constitute a large part of his work, and make it an exceedingly valuable contribution to zoological science.

[2] The experiments mainly of Dr. Wyman, of which an account is given in the work at some length, are here referred to.

[3] Prof. Clarke speaks of the *Bacteria* as probably related to vegetable mould; and, after a microscopic study of certain *Vibrios* obtained by Dr. Wyman in his trials, pronounces them also *vegetable*.

In view of these facts, that from life has come the new life, and from the high only the *extremely low*, the assumption, cited above, which makes the second grand conclusion of Prof. Clark, "that still higher forms could therefore arise from these," is certainly without even the shadow of a foundation. Such spontaneous generation does not begin to climb the hill of life; it looks *downward* and not upward.

The best statement which we have seen of the relation of the generated organism—supposing it a real generation without germs—to the original organic matter, is that made by the chemist Fremy to the French Academy, and which we have reproduced (translated from the French) into this Journal, in vol. xxxviii, at page 439 (Nov., 1864).

But the absence of germs, although seemingly possible, is far from being proved, as Mr. Child admits. The high temperature used in the course of the experiments on spontaneous generation is sufficient, it is true, to destroy the life of ordinary plants or animals, but it does not decompose the vegetable or animal material employed in the trials. And, considering the low order of the organisms that are developed, it cannot be assumed that heat which this material stands will destroy their germs.

The following observations, communicated to the writer by Prof. W. H. Brewer, the Botanist of the Survey of California, as well as Assistant in the Geological department, show that plants of low grade may thrive in waters very near if not at the boiling point, and even when strongly acid or saline.

Observations by Prof. W. H. BREWER *on the presence of living species in hot and saline waters in California.*

Dear Sir:—In answer to your request I can give the following facts regarding the occurrence of plants in certain thermal springs, and animals in certain saline waters, of California.

The (so-called) Geysers on Pluton creek, a branch of the Russian river, lie at an altitude of 1700 feet above the sea. They consist of numerous steam vents, and hot springs, of various temperatures, the hottest observed being 97° C. (about 207° F.).

The temperature of the steam in the larger vents was not observed. It issues from some of them with a noise as if released from considerable pressure. The waters contain a variety of salts in solution, apparently mostly the sulphates of iron and alumina; and efflorescences of sulphur, and sulphurous gases are abundant. From most of the springs the water is decidedly acid, discoloring the boots, gloves, and clothes of the visitor.

In these warm mineral waters low forms of vegetation occur. The temperatures were carefully observed in many cases. The highest temperature noted in which the plants were growing

was 93° C. (about 200° F.) But they were most abundant in waters of the temperature 52° to 60° C. (125° to 140° F.) In the hotter springs the plants appeared to be of the simplest kind, apparently simple cells, of a bright green color; but they were examined only with a good pocket lens. In the water below, about 60–65° C., filamentous Confervæ formed considerable masses, of a very bright green color.

Around many of the steam jets, on the soil, similar or identical plants formed a thin green coating, like *Nostoc* on wet surfaces. Here they were exposed alternately to jets of hot steam and cooler air. The highest temperature they were subjected to could not be observed; but the soil was hot, and as the steam was often "dry" and transparent, it was equal to, if not above, the temperature at which water boils at that altitude.

The specimens I collected were accidentally destroyed on our return trip; but later Messrs. Mann and Brigham collected specimens from water having a temperature of about 130° F. A part of these were placed in the hands of Dr. Jeffries Wyman of Cambridge, and Mr. A. M. Edwards of New York. The latter person states that he finds animal as well as vegetable organisms in the specimens.

At the "Little Geysers," a few miles distant from those last mentioned, and at an altitude of 2000 feet or more, the same phenomena were observed; but the altitude being greater, the waters were not quite so hot.

These observations were made in November, 1861, and the facts communicated verbally to the California Academy of Natural Sciences the following winter.

Plants occur also in various other thermal waters in the State. They were noticed in great abundance in water having a temperature of 122–125° F. in a warm spring in Owens Valley, about 35 miles above Camp Independence.

The celebrated Steamboat Springs, near Washoe Valley, in Nevada, are very extensive, and the waters hold much silica in solution, which is deposited as they cool. Where the water spreads out over the surface there is in places an abundant growth of confervoid vegetation in the gelatinous mass formed. This was most abundant where the temperature was about 100° F. or less, judging of the warmth of the water by the hand. The most interesting feature in this case is the abundant vegetable growth in the gelatinous silica.

In regard to the occurrence of *animals* in strongly *saline* waters, some facts are of equal interest. Mono Lake is intensely saline. The water has a very high specific gravity, and contains common salt, carbonate of soda, and borax, with other ingredients in less quantities. It dissolves grease easier than ordinary soap, and discolors certain woolens. It leaves a very

unpleasant smarting sensation on the skin, and feels soapy to the touch. Yet it contains the larvæ of a certain species of fly in immense numbers. These are cast up on the shore at times in such quantities that a great stench is produced. These larvæ dried form an important item of food with the Mono Indians, who call it "*Koo-chah-bee.*" The flies are seen in equally large numbers about the shores of the lake.

Similar flies are mentioned as occurring at the Great Salt Lake, by various persons. Lieut. Stansbury speaks of their immense numbers in his Report, but we have no facts as to their specific identity.

New Haven, March 26, 1866.

We append the following important note on *the tenacity of life of the seeds and spores of some plants*, prepared for this place by Prof. Brewer.

Note by Wm. H. Brewer.—Edwards and Colin (Annales des Sci. Nat., [2], Bot. I, 257) made experiments on the power of resisting elevated or depressed temperature possessed by the seeds of various leguminous and cereal plants. They found that all lost their vitality if heated in water at 167° F., which is the temperature at which starch grains burst. The most of the seeds had their vitality destroyed when heated in water below this, but would stand a temperature of 122°; while in steam they would stand 144° F.; and in *dry* air some germinated after being heated a very short time to 167° F. Above this all lost their vitality. Some would stand a dry cold of 70° F. below zero.

Berkley states (Introduct. to Cryptogam. Bot., p. 68) that he has "recorded an instance of the germination of thousands of grape seeds after three immersions in boiling water; and Dr. Lindley mentions the fact of raspberry seeds growing after being boiled for jam, in which case, if the sugar were really boiling, the temperature would be above the boiling point of water." The author considers, however, that the observations were not sufficiently exact in either case.

Balfour states (Class Book of Botany, p. 628) "the seeds of *Phytolacca decandra* and of the Raspberry have been known to germinate after exposure for a short time to the heat of boiling syrup," but does not give his authority.

Hemmingway states (Ann. of Nat. Hist., [1], viii, 317) that the seeds of *Sambucus nigra* germinated after being twice boiled in making wine, being present during the vinous fermentation, and remaining twenty months in the dregs of the cask.

In regard to the spores of Fungi, Berkley remarks (Outlines of British Fungology, 32) "that the spores of certain Fungi would bear a moist heat equal to that of boiling water without losing their power of germination. They have also considerable powers of resisting frost, but the exact limits in either case under varying circumstances have not at present been ascertained."

More to the point are the experiments of the eminent cryptogamic botanist, Payen, on the red mould in the interior of bread, which created such a stir in Paris nearly twenty years ago. This mould, the *Oidium*

aurantiacum, was developed in the interior of the bread within an incredibly short space of time after it had been baked, especially in the Barrack-bread, ("pain de munition,") at Paris. He found (Ann. de Chim. et de Phys., [3], xxiv, 253) that pieces of bread, and also of dough, upon which the spores of this fungus had been sown, and then exposed in tubes in moist air for half an hour to the respective temperatures of 212°, 221°, and 248° F., afterwards produced the red fungus; while similar pieces of bread and dough, treated in a similar manner but not sown with the spores, did not yield this specific fungus. When the spores were heated in tubes to 284° F. they lost their red color, and then ceased to germinate.

It seems that in this case, as in that of the cereals, the vitality of the seeds or spores is retained under certain circumstances up to nearly or quite the temperature required to decompose the chemical substances in the seed, or to disorganize the structure. In the still lower Cryptogams we have no data either as to the chemical character of their spores, the temperatures required to change their organic compounds, or to disorganize their structure, and none whatever as to the temperatures they may withstand and still germinate. It seems, therefore, unsafe to assume, without proof to the contrary, that their vitality (germinating power) is destroyed at a temperature much below that required for their actual destruction or disorganization.

One of the most remarkable examples of tenacity of life in the higher plants is presented by the *Lewisia rediviva* of Western North America, a large-flowering fleshy plant, of the Portulaceæ, growing in British Columbia, Oregon and California. Dried specimens that have been two years or more in an herbarium will still grow, and are often troublesome from sprouting while between the papers. One specimen, collected by Dr. Lyall, of the British Navy, was "immersed in boiling water" to stop this growing propensity before drying it; and yet, more than a year and a half afterward, it showed symptoms of vitality, and in May of 1863 it produced its beautiful flowers in the Royal Gardens of Kew. This plant in flower is figured in Curtis's Botanical Magazine for August of that year. It is very desirable that some special experiments should be made to ascertain just how much boiling it may undergo without loss of vitality.

April 6th, 1866.

ART. XLIX.—*On the Corundophilite of Shepard;* by F. PISANI.

THE mineral from the emery mines of Chester, Mass., which Prof. Shepard has pronounced to be his Corundophilite, occurs on the emery in lamellæ grouped parallel to the base of the prism, somewhat irregularly, and is associated at times with emerylite. The lamellæ are of a dark green color, translucent when quite thin, and flexible without elasticity. Cleavage is very easy parallel to the base. In a polarizing microscope the plates show two optical axes inclined as in clinochlore, with the double refraction positive.

The mineral fuses easily before the blowpipe to a brown scoria, and chlorhydric acid attacks it in part. The spectroscope affords evidence of traces of lime and lithia. Prof. Shepard has given for the composition, $\dot{S}i$ 34·75, $\dot{A}l$ 8·55, $\dot{F}e$ 31·25, $\dot{H}$ 5·87 = 80·02; and the loss of 20 p. c. he regarded as mostly alkalies.

The analysis which I have made of the Chester corundophilite, as well as the optical properties examined in detail by Mr. Des Cloizeaux, place the species with the ferriferous clinochlores (ripidolite). My analysis afforded me—

		Oxygen.		Ratio.
Silica,	24·0	12·79		6
Alumina,	25·9	13·06		6
Protoxyd of iron,	14·8	3·28	12·36	6
Magnesia,	22·7	9·08		
Water,	11·9	10·60		5
Lime, lithia, manganese,	trace			
	99·3			

Paris, February, 1866.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the wave-lengths of Fraunhofer's lines.*—Ditscheiner has communicated to the Imperial Academy of Sciences at Vienna the results of an extended investigation of the wave-lengths of the dark lines in the solar spectrum. The author employed a ruled glass plate from Fraunhofer's own hand, and a Meyerstein's spectrometer. For the details we must refer to the original memoir. The numerical results obtained are the following, the numbers in the first column referring to Kirchhoff's well known map of the spectrum. The author extended his determinations as far as H, but we omit this portion of his table of results because it requires a special map. The wave-lengths are expressed in millionths of a millimeter.

Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.
B 593	687·06	1029·4	585·62	1343·5	545·45
C 694	655·95	1096·1	576·09	1351·3	544·48
711·5	651·37	1103	575·15	1367	542·82
719·5	649·34	1135	570·88	1389·6	540·32
783·5	633·55	1155·7	568·08	1410·5	538·19
831	622·92	1174·4	565·71	1421·6	536·93
850	618·94	1200·4	562·35	1451	533·92
860	616·82	1207·5	561·36	1463	532·70
864	616·05	1218	560·15	1492·5	529·64
874·5	614·06	1231·6	558·52	1506·5	528·21
877	613·57	1242·5	557·16	1515·5	527·43
885	612·09	1280	552·66	E 1523·5	526·86
895	610·15	1303·7	550·52	1542	525·41
959	597·48	1307	550·09	1569·8	523·16
Dδ 1002·8	589·44	1324·8	547·53	1577·5	522·52
Dα 1006·8	588·80	1337	546·18	1589·1	521·40

Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.	Kirchhoff.	Wave-length.
1601·6	520 75	2002	491·78	2457·5	456·31
1622·4	519·10	2018	490·87	2467·4	455·21
1634	518·16	2041·4	489·00	2489·4	453·23
b 1648·8	517·13	2058	487·64	2537·1	450·06
1655·6	516·58	2067 ·	487·01	2547·2	449·64
1693·8	514 08	F 2080·1	485·97	2566·3	447·97
1737·6	510·86	2103·3	484·10	2606	445·51
1750·4	509·74	2119·8	482·28	2627	444·16
1777·4	507·85	2148·9	480·03	2638·6	443·36
1799	506·35	2157·4	479·02	2670	441·40
1834	504·00	2160·6	478·70	2686·6	440·39
1854·5	502·70	2187·1	476·41	2721·6	438·27
1867	501·71	2201·9	475·38	2734·9	437·32
1873·5	501·12	2221·7	473·82	2775·6	435·19
1885·8	500·52	2233·7	472·84	2797	433·86
1908·5	499·17	2250	470·74	2822·8	433·34
1920	498·23	2264·3	470·19	G 2854·7	430·88
1961	495·61	2309	466·56	2869·7	429·90
1975·6	494·50	2416	460·12	H	396·68
1983	493·80	2436·5	458·16	H′	393·32
1989·5	493·22				

—*Sitzungsberichte der k. k. Akad. der Wissenschaften*, I, Band 296.

W. G.

2. *On the mechanical equivalent of light.*—Professor THOMSEN of Copenhagen has given an ingenious method of determining the mechanical equivalent of light based upon the principle that light may be converted into heat by absorption when incident upon a black surface without luster. The heat produced was measured by means of a Melloni's apparatus, the indications of which were reduced to absolute measure. To effect this reduction a glass globe filled with warm water was placed at different distances from the thermo-electric battery. The globe contained 1351 grams of water (including the water value of the glass). At a temperature of 50° C. the cooling of the globe was 0°·185 per minute, so that $1351 \times 0°{\cdot}185 = 250$ units of heat were lost in all. Of this quantity, however, according to Dulong's formulas, only 102 units of heat per minute were lost by radiation alone, the external temperature being 17° C. This source of heat placed at a distance of 0·8 meters from the thermopile produced a constant deviation of 17°·8; hence any source of heat or light, which at a distance of 0·8 meter from the thermopile produces a deviation of 17°·8 C., radiates 102 units of heat per minute; and since the deviations of the needle within certain limits are proportional to the radiation, it follows that under these circumstances a deviation of 1° corresponds to a radiation of 5·76 units of heat per minute. By placing the globe at different distances from the thermopile and noting the deviations of the needle, similar factors were obtained for some other distances at which afterward the different sources of light were placed. A candle was then placed at a distance of 0·8 meter from the thermo-pile and a constant deviation of 36°·5 obtained. Hence the total radiation of a candle burning 8·2 grams of spermaceti per hour was $5{\cdot}36 \times 36°{\cdot}5 = 210$ units of heat per minute. Since the corresponding quantity of spermaceti evolves about 1400 units of heat per minute, it follows that only $\frac{1}{7}$th of the whole quantity of heat evolved is given off as radiant heat and light, the other $\frac{6}{7}$ths being carried off by heated air.

Other and more intense flames were then tried; the results were as follows:

Nature of the flame.	Intensity of light.	Radiation for unit of light per minute.
Spermaceti candle,	1	210
Gas flame,	1·2	201
"	7·7	199
Moderator-lamp,	8·6	199

Hence the radiation of the flame is proportional to the intensity of the light and amounts, for the unit of light (8·2 grams of spermaceti per hour), to about 200 units of heat per minute. This is the action of the entire radiation, and to determine the portion due to the light alone the rays of heat must be eliminated. The author found by experiment that the invisible rays do not pass through a layer of water 0·2m. in thickness, or at least to so small an extent as to exert no appreciable influence on the result. Further experiments then showed that the absorption of light due to a layer of water 20 centimeters in thickness amounted to 0·13. A glass vessel with parallel sides of mirror-glass enclosing a layer of water 0·2m. in thickness was placed between the flame and the thermopile, the flame being at the same distance as in the first experiments. The deviation of the needle was therefore due exclusively to the heat produced by the rays of light. The results were as follows:

Flame.	Intensity of light.	Radiation of heat and light per minute for the unit of light.	Radiation of light per minute for the unit of light.
Spermaceti candle,	1	210	4·4
Moderator-lamp,	6·25	—	3·9
"	8·6	199	4·1
Gas flame,	7·7	199	4·2
"	1·2	201	3·7

The mean is 4·1 units of heat per minute. Hence in words the result is this: A flame, the light of which is equal in intensity to that of a candle which consumes 8·2 grams of spermaceti per hour, evolves per minute in the form of light a quantity of heat which would raise the temperature of 4·1 grams of water one degree Centigrade. The mechanical equivalent of light reduced to mechanical measure may then be expressed as follows. The unit of work per second, or one kilogram raised to the height of one meter per second, is equal to that contained in the rays of light which proceed per second from a source of light the intensity of which is 34·9 times as great as that evolved in a candle which consumes 8·2 grams of spermaceti per hour.

This is consequently the maximum of the mechanical equivalent of light and may be reduced by later researches. The author proposes to continue his investigations, using light of greater intensity, like that of the sun or of the electric spark.—*Pogg. Ann.*, cxxv, 348. W. G.

3. *Niobium and tantalum.*—The continued investigations of Marignac, supported by those of Blomstrand, to which we have already alluded, and by new determinations of vapor-densities by Deville and Troost, have at length dispelled all doubts as to the true constitution of niobic and tantalic acids. From these investigations it clearly appears that these acids are represented respectively by the formulas, NbO_5 and

TaO_5, in equivalents, or Nb_2O_5 and Ta_2O_5 in atoms. The columbites or tantalites of Bodenmais, Greenland and Haddam all contain both acids; thus the mineral from Bavaria contains 35·4 per cent of tantalic and 45·66 per cent of niobic acid, while the Haddam columbite contains at least 10 per cent of tantalic acid. There is no hyponiobic acid, but the white chlorid discovered by Rose, and which he considered as a sesquichlorid of niobium, Nb_2Cl_3, is in reality an oxychlorid, NbO_2Cl_3; the true chlorid of niobium is $NbCl_5$. There exists an oxyfluorid of niobium, NbO_2F_3, which combines with fluorid of potassium to form a well crystallized salt having the formula $NbO_2F_3, 2KF+2aq$. By the action of strong fluohydric acid upon this salt a fluoniobate of potassium having the formula $NbF_5, 2KF$ is formed, and this salt is isomorphous with the corresponding fluotantalate $TaF_5, 2KF$. The oxyfluorid of niobium, $NbOF_3$, is isomorphous in almost all its combinations with the fluorids of titanium and tin, TiF_4 and SnF_4, and with the oxyfluorid of tungsten, WO_2F_2, a fact which Marignac explains by supposing that an atom of oxygen, O, is isomorphous with an atom of fluorine. The ilmenic acid of Hermann has no existence, and the dianic acid of v. Kobell is merely niobic acid, but Hermann was right in maintaining, against the authority of Rose, that the Bavarian columbite contained tantalic acid, and that Rose's niobic acid was a mixture of tantalic acid and Rose's hyponiobic acid. Marignac separates niobic from tantalic acid by converting the first into $NbO_2F_3, 2KF+2aq$, and the second into $TaF_5, 2KF$; the solubility of the former being about ten times as great as that of the latter the two are easily separated by repeated crystallization. In analyzing the oxyfluoniobate of potassium for the purpose of determining the equivalent of niobium, Marignac found a small quantity of another and analogous salt about five times less soluble than the niobium salt; this may prove to contain a new metallic acid, but the author reserves his opinion upon this subject for the present. The atomic weight of niobium was found to be 94, a number which however must be considered as only provisional. The density of pure niobic acid was found to be 4·37–4·46; prepared in another manner it was 4·51–4·53. The acid forms well crystallized salts with potash, contrary to the statements of Rose and Hermann. Marignac describes compounds having respectively the formulas

$$3Nb_2O_5, 4K_2O, 4H_2O+12aq,$$
$$7Nb_2O_5, 8K_2O, 9H_2O+23aq,$$
$$2Nb_2O_5, 3K_2O, 6H_2O+7aq,$$
$$3Nb_2O_5, 3K_2O, Na_2O, 9H_2O,$$
$$3Nb_2O_5, K_2O, 5H_2O.$$

The oxyfluoniobate of potassium, $NbOF_3, 2KF+H_2O$, is a perfectly stable salt which does not change by repeated solutions and crystallizations; it loses its water at 100° C., but may be dried completely at 180° or 200° C., and then redissolves in water without decomposition. The salt dissolves in 12·5–13 times its weight of water at 17°–21° C., and is much more soluble in boiling water. Another oxyfluoniobate has the formula $NbOF_3, 3KF$; its crystals appear to be cubes, but an optical examination showed that they do not belong to either the regular or dimetric system. A fluozirconate of potassium, having the formula

ZnF_4, 3KF, crystallizes in regular octahedrons, while of the salts SiF_4, $3NH_4F$ and TiF_4, $3NH_4F$, the first crystallizes in square prisms and the second either in square prisms or cubes. The other oxyfluoniobates described have the formulas $Nb\Theta F_3$, 3KF, HF, isomorphous with SnF_4, 3KF, HF; $3Nb\Theta F_3$, $5KF+H_2\Theta$ and $3Nb\Theta F_3$, 4KF+2aq. The fluoniobate of potassium, NbF_5, 2KF, is easily obtained by dissolving the normal oxyfluoniobate in strong fluohydric acid; though small the crystals are brilliant and easily measured; redissolved in water they give an abundant crystallization of oxyfluoniobate and leave a strongly acid mother liquor. In addition to several oxyfluoniobates of ammonia the author describes salts of zinc and copper having respectively the formulas $Nb\Theta F_3$, ZnF_2+6aq, isomorphous with fluosilicate, fluostannate and fluotitanate of zinc, and $Nb\Theta F_3$, CuF_2+4aq, isomorphous with fluotitanate and oxyfluotungstate of copper.

Deville and Troost have determined the vapor-densities of both chlorid and oxychlorid of niobium, and Marignac has proved by careful analysis and examination that the chlorid employed by the French chemists contained no appreciable quantity of chlorid of tantalum. The density of the vapor of the oxychlorid of niobium, $Nb\Theta Cl_3$, taken at 448° C. in the vapor of sulphur was found to be 7·87, and taken in the vapor of cadmium at 860° was found to be 7·89; the formula given requires 7·48, while Rose's formula, Nb_2Cl_3, would require 7·05. In like manner the vapor-density of chlorid of niobium was found to be 9·6; the formula $NbCl_5$ (Nb=94) requires 9·4, while Rose's formula requires 8·6.

The minerals tantalite and niobite have, according to Marignac, respectively the formulas $Ta_2\Theta_5$, $Fe\Theta$ and $Nb_2\Theta_5$, $Fe\Theta$ (in equivalents TaO_5, FeO and NbO_5, FeO). The tantalite from Kimito represents the first and the niobite from Greenland the second type, and the different varieties of columbite lie between these extremes. The atomic weight of tantalum, if we consider tantalic acid as TaO_5, would be about 172. In conclusion Marignac acknowledges the priority of Blomstrand in the discovery of the true constitution of niobite and tantalite, and as regards other results obtained by that chemist which, except as to the atomic constitution of the two acids, agree entirely with his own.—*Bibliothèque Univ. de Geneve*, xxiii, p. 167 and 249; Deville and Troost in *Comptes Rendus* for June 12th, 1865; also Marignac in *Ann. der Chemie und Pharm.*, cxxxvi, p. 295. W. G.

Note.—Marignac's researches clearly show that niobium and tantalum are pentatomic or quinquivalent, and they are thus associated with the nitrogen group, which therefore contains nitrogen, phosphorus, arsenic, antimony, bismuth, niobium and tantalum. Niobic and tantalic acids appear in their normal compounds to be monobasic like nitric, metaphosphoric, antimonic and bismuthic acids, but the bibasic and tribasic character appears in the double fluorids and oxyfluorids NbF_5, 2KF, NbF_3O_2, 2KF, NbF_3O_2, 3KF, and TaF_5, 2KF. The oxychlorid of niobium has its analogue in the well known oxychlorid of phosphorus, PCl_3O_2.—W. G.

4. *On Yttria and Erbia.*—Bahr and Bunsen have published the results of an elaborate investigation of the earths found in gadolinite, and

have, as appears, succeeded completely in overcoming the difficulty of separating and discriminating between yttria and erbia, the metal terbium having no existence. It will be remembered that Popp has recently endeavored to show that but a single earth, yttria, exists in gadolinite, while De la Fontaine has maintained the existence of the three discovered by Mosander. Bahr and Bunsen separate the oxyds of cerium, lanthanum and didymium from yttria and erbia by means of sulphate of potash, repeating the operation until the solution no longer exhibits the absorption bands of didymium with the spectroscope. Yttria and erbia were separated by converting the oxyds into nitrates, heating the mixed nitrates until the first gas-bubbles of nitrous acid were given off, boiling the mass in just sufficient water to give a clear solution, and separating the crystals of basic nitrate of erbia formed on cooling. In this manner by repeated operations the two earths were finally separated, the equivalent of yttrium being found to be 30·85, while that of erbium is 56·3. Erbia, as obtained by igniting the oxalate or nitrate with access of air has a faint rose-red color, and does not fuse at a white heat, but glows with an intense green light. The salts of erbia are more or less bright rose-red; they have an acid reaction and a sweetish astringent taste. Sulphate of erbia has the formula $3(ErO, SO_3)+8aq.$ like the sulphates of yttrium, didymium and cadmium, and forms permanent rose-red crystals. The basic nitrate has the formula $2ErO, NO_5+3aq$: the oxalate is $ErO, C_2O_3+aq.$ The authors give figures of the absorption spectra of erbium and didymium and show that the two contain no lines in common and that there are no absorption bands from which the existence of terbium can be inferred. The errors of previous observers in this particular are due to the fact that the broad indistinct bands in both spectra vary with the intensity of the light and the degree of concentration of the solutions. Erbia and the oxyd of didymium are distinguished from all hitherto observed substances by a most remarkable optical peculiarity. The *solid* substance when strongly ignited gives a spectrum with bright bands which in the case of erbia are so intense that they may be used as a means of recognizing the earth. Ignited erbia gives out a green light and appears to be surrounded by a greenish halo, which, however, depends simply upon irradiation. The spectrum of erbia is more intense and complete when in place of the dense oxyd the porous mass obtained by igniting the nitrate quickly upon a fine platinum wire is employed. The same effect may be obtained by moistening the oxyd with a solution of phosphoric acid before ignition and repeating the operation as long as an increase in the intensity of the spectrum is observed. Too large a quantity of phosphoric acid converts the earth completely into phosphate which gives only a faint spectrum. By either of these methods a spectrum of extraordinary beauty is obtained scarcely inferior to that of baryta in intensity and distinctness. The bright lines of the spectrum of ignited erbia exactly correspond to the dark lines produced by absorption in solutions of erbium, and the same is the case with bright and dark lines of didymium. The properties of the two oxyds lead to the remarkable conclusion that the position of the spectral lines of any substance may remain the same whether the temperature be below 0° C. or exceed the freezing point of water by thousands of degrees.

When the light of a luminous gas-flame passes through a crystal of sulphate of didymium only 1 millimeter in thickness and then falls upon the slit of the spectroscope we obtain an absorption spectrum of extraordinary sharpness and beauty in which not less than 17 bands may be distinguished. The spectrum of a solution of didymium contains one line which is not found in the spectrum of the solid sulphate and this last contains one line not found in the spectrum of the solution. That this is not an error of observation is shown by producing the absorption spectrum of this crystal and then bringing a solution of didymium between the crystal and the source of light, when both bands appear. Hence it is clear that in the passage from the liquid to the solid state spectral lines may disappear and new ones may be produced. Bahr and Bunsen consider it certain that the spectra of erbia and didymia are due to the compounds of the metals and not to the metals themselves, which are not reduced by ignition. They remark that the absorption spectra are the same respectively for all the salts of the two metals. Yttria, as prepared in a state of purity forms a soft nearly white powder which, when ignited glows with a pure white light and gives no trace of an absorption or emission spectrum. The solutions are colorless and have an acid reaction and sweet astringent taste. The sulphate of yttria forms transparent colorless crystals which have the formula $3(YO,SO_3)+8aq.$ The basic nitrate $2YO,NO_5+3aq.$ forms colorless needles; the oxalate is perfectly white and has the formula $YO.C_2O_3+aq.$ For the quantitative estimation of yttria and erbia the authors recommend the conversion of the weighed mixture of oxyds into sulphates. From the weight of acid the relative properties of the oxyds may be determined by the method of indirect analysis. In conclusion, an elaborate analysis of gadolinite is given leading very precisely to the formula $2\dot{Y}_3\ddot{S}i+\ddot{B}\ddot{S}i$ or more simply $\ddot{S}i\dot{R}_3$ if glucina be considered a protoxyd.—*Ann. der Chemie und Pharm.*, cxxxvii, 1, Jan. 1866. W. G.

II. MINERALOGY AND GEOLOGY.

1. *Notes on Chalk and Cretaceous Deposits in Eastern Colorado;* by D. C. Collier, Editor of the "Daily (Colorado) Miner's Register."—In crossing the plains from Denver, Colorado, to Atchison, Kansas, last November, I was so fortunate as to make some geological and paleontological discoveries which may be of interest to the scientific public, an account of which, by request of Prof. James D. Dana, I herewith transmit for the Journal.

I first emigrated to Colorado in the year 1858. In passing up the Arkansas river I found, upon many of the nearly barren ridges and hills, about three hundred miles west of the Missouri river, fragments of indurated chalk intimately mixed with silex and containing nodules of flint. At that time I was travelling through an unknown region, with but five companions, and had no opportunity to examine the white bluffs to be seen in the distance. On approaching the base of the mountains we turned northward from the Arkansas, and crossed over the dividing ridge which separates the waters of that river from those of the Platte. In doing so I found a large portion of the rocks to consist of a white or whitish con-

glomerate. They were composed of a fine-grained or rather grainless substance, chalk-like in appearance, combining water-worn pebbles of white quartz and flesh-colored feldspar, mostly the former. Wherever the strata of this rock remained horizontal, or nearly so, I found it usually covered with a thin stratum of hard clinking red ferruginous conglomerate. Wherever bluffs of the white conglomerate existed, they were thus overlaid, and were worn into an infinite variety of monumental and architectural forms, which gave them, in the distance, an appearance of being old ruins. From these, Monument Creek has since received its name.

Underlying the Cretaceous conglomerate I found immense strata of a green argillaceous shale or marl, which in appearance closely resembles the greensand of New Jersey, as I have seen it this winter. This green marl I afterwards found to be very abundant. In the black shales and slates, which are highly friable, and which appear to underlie the green marl, I found immense deposits of bituminous lignite or coal, in layers from a few inches to nine feet in thickness. Still lower down, geologically, I found extensive deposits of fossil shells, mostly Baculites and Ammonites. On one occasion, in the year 1861, at a point on the Platte river sixteen miles above Denver, I uncovered, in a space not more than six feet in diameter, the shells of eighteen Baculites which had been crushed flat but retained all their beauty of outline and brilliancy of color. After being exposed for a few minutes they crumbled to fragments. The longest of these was about four feet in length; the smallest but a few inches.

In the fall of the year last mentioned, in company with other gentlemen, I examined cursorily the stratified rocks, from the point where they overlap the metamorphic granites of the mountain range where the Platte river issues out on the plains, and for a mile eastward. I found the rocks there tilted at an angle of fifty degrees, dipping from the mountains. They were composed first of micaceous shales, and then of strata of siliceous conglomerates, sandstone, limestone, a kind of red and white marble, gypsum, argillaceous shale containing alum, etc.

The inclination of the rocks we found to be about fifty degrees for a distance of fully two miles, wherever the outcrop was not so decomposed that we could not trace it, and where it was not concealed from view by soil. Encrinites and Asterias were often found in the upper deposits, as also fragments of petrified palm and other endogenous plants.

My residence being in Central City, surrounded on every side by granitic rocks, and business engrossing my entire attention, I was not able to devote any further attention to this subject till last November, when I crossed the plains on one of the coaches of the Butterfield line which then traversed what is known as the Smoky Hill route, down the Smoky Hill river, midway between the Arkansas and Platte rivers. For two hundred and fifty miles eastward from Denver we travelled day and night, and of course had little or no opportunity to examine rocks. After travelling that distance, fortunately for me, we came to a point where the Indians had driven off the stock, killing drivers, messengers and stock-tenders. This compelled slow travelling and frequent stoppages for our stock to rest. With my revolver cocked in my hand ready for an Indian

fray, I was able often to go half a mile from coach or camp among the bluffs. On one occasion, in company with a companion I was able to climb to the top of a bluff of pure chalk, so soft that I could cut and carve it with the knife I carried in my belt, and so fine that it covered my clothes as thoroughly as when in my college days a classmate wiped the blackboard with my back. On the summit I found the remains of immense shells, some of which were nearly four feet in diameter. Among others were remains of Belemnites in immense quantities, but these latter I oftener found closely connected with the green shales which I am inclined to believe underlie the chalk.

When in the midst of these Indian fiends, at a distance of half a mile from the coach, I found the fossil jaw of a Mosasaurus, which, though broken in fragments, appeared to have been about four feet in length. The teeth remained whole, and the front extremity of one of the jaws was also complete. This portion, about fourteen inches in length, and also a portion of the vertebræ I carried along on one arm, with my revolver cocked in the hand of the other, till I overtook the coach, leaving behind the other bones, which I greatly coveted. This appeared to have been deposited in connection with green shales, which were readily disintegrated into what closely resembled a marl, and which often contained nodules or accretions of sulphid of iron.

After travelling in this way for some distance we were supplied with a military escort, the commandant of which put an end to my wandering away from the road, and thus ended my geological research.

The chalk bluff extends for a distance of over one hundred and fifty miles east and west, and may be found first at a distance of about three hundred and fifty miles west from Leavenworth, Kansas.

As the coach was driven rapidly along I could see many fossils by the wayside, and in the bluffs, which seemed to be chalk, much higher than those I have mentioned, but we travelled with so much haste and were surrounded with so many enemies, that I was unable to decide the relative position of these interesting rocks. While in the midst of these localities, and when crossing the outcroppings of the coal deposits, we were attacked by Indians, who were repelled only after killing five of their number and after they had wounded one of ours. Our only stoppage by the way, after being joined by the military, was to bury the bones of white men who had been murdered by Indians and stripped of their flesh by wolves.

The fossils which I obtained on this trip are now in the Cabinet of Oberlin College, Ohio, to which I gave them.

Brooklyn, N. Y., April 4th, 1866.

2. *Volcanic eruption at Santorin, Grecian Archipelago, and the formation of a new island in the Bay.*—Translation of a letter from J. DECIGALA, dated Santorin, January 23, 1866, by Mr. Canfield, American consul at Athens, as published, with illustrations from photographic views, in Harper's Weekly, April 7.

A remarkable phenomenon has for several days occupied the attention of the inhabitants of Santorin. On the 18th instant a low rumbling sound was heard from time to time in New Kaimeni, and especially at the place called Vulcano, where are the mineral waters. At the same

time stones detached from different parts of the island were constantly falling about. The morning of the 19th cracks could be seen on the walls of buildings, as also in the ground and the newly erected quay. Toward noon the rumblings began to be more frequent, till they sounded like successive discharges of artillery. In the little harbor of Vulcano the sea was violently agitated, and an innumerable multitude of bubbles rose incessantly from the depths. At the same time we could see on its surface and on its borders white vapors giving an odor of sulphur. The afternoon of the same day the boiling of the sea increased, and the ground on the beach commenced gradually to sink down. On the morning of the 20th, about five o'clock, flames, forming a conical fire ten to fifteen square meters at the base and from four to five in height, were seen on the sea. After an hour they entirely disappeared. We then went upon the spot with the sub-prefect and some others to make a nearer examination of the phenomenon. We then saw that the whole southwestern part of New Kaimeni was shattered to pieces. A chasm, commencing at the western shore near the port of St. George, and directing itself toward the east, divided in two equal portions the conically formed hill and almost the entire island. Other numberless rents, some running from east to west, others from north to south, separated into a number of parts the ground of the whole southwestern portion of the island. This land, which is formed not of layers of earth but of an accumulation of volcanic stones and sand, or rather of the powder of basaltic rocks, was always very dry and in no way susceptible of vegetation. We saw here four little lakes of pure water, whose size was slowly increasing; for having measured the largest of all, which had hardly an area of twelve square meters, we saw its waters rise five centimeters within four hours. We advanced toward the focus of the volcanic action and perceived a sulphurous odor like that of rotten eggs. White and suffocating vapors arose from the agitated sea, and from time to time we saw spots appear of greenish color, proving that the vapors which arose were of hydro-sulphurous and hydro-phosphoric [?] nature. The ground was constantly shaken, though it subsided very slowly, directing itself toward the interior of the port in question. This depression of the ground was much more perceptible toward the western portion than the eastern: this last showed a depression of hardly three meters, while the western portion had sunk more than six meters. This subsidence, as I have said, took place insensibly and gradually; for having measured the surface of the waters at the moment of our arrival and that of our departure, we saw that in the space of four hours the soil of the western portion had sunk sixty centimeters (about two feet.)

The sea was agitated and red, like water containing a great quantity of argillaceous mud. Its temperature was that of the rest of the sea, but it tasted bitter, and when taken up in a transparent vessel appeared turbid. The effervescence was very great, and doubtless came from the abundant springs containing sulphate of iron, which spirted up with force from its depths, accompanied with much noise from the gases escaping with violence. About 5 P. M. of the same day we felt at Santorin a slight shock. * * * *

P. S.—N. C., *Jan.* 23, 11·30 A. M.—The reef has been changed to an island, to which I am unable to approach very closely on account of the

temperature and the boiling of the water. I approached, however, on the land side within a distance of ten paces, and could observe all with perfect attention. The sight is a magnificent one, and the more agreeable since, without the least danger, we can see the island gradually increasing. The smoke, although thick, and rising in abundance from all parts of the rising island, has neither a disagreeably strong odor nor a very high temperature, and in no way impedes the respiration. There are no flames to be seen, and even the boards of huts destroyed by the subsidence, or belonging to the little vessels long since sunk in this port, and to-day raised with the bottom of the sea, appear attached to the rocks on the surface of the island, preserving themselves in the midst of the smoke without being at all burned. There are no quakings of the ground to be noticed. * * *

Now, as I am writing, I estimate the height of the islet at from 15 to 20 meters, and its size 20 to 25 meters in length by 8 to 10 in breadth. The subsidence of the neighboring soil appears to-day to have been arrested. The water of the entire Gulf of Santorin is, as yesterday, colored and thick. On the shores of New Kaimeni it is lukewarm, while on the spot where the eruption takes place, and on the west of Vulcano, along its exterior shores, it is in a state of constant ebullition. It is singular that these volcanic phenomena have as yet exercised no influence on the island of Santorin, except a slight shock, which made itself felt at five o'clock the morning of the 20th instant. The meteorologic condition has never exercised any influence upon these phenomena; for whether calm, or when violent winds were blowing from different points of the compass, or even amidst the rain, they have continued to operate alike.

3 P. M.—The island has increased to nearly double its former size. * *

3. *Notes on some points in the geology of Kansas;* by Prof. G. C. SWALLOW, (from a letter to J. D. DANA, dated Columbia, Mo., March 15, 1866).—Some months since I was permitted to examine the fragment of the lower jaw of a horse containing two molars, which was obtained from the sand-beds between the Bluff and Drift, at Maysville, Kansas. This and other bones were found by the Hon. E. C. Manning while sinking a well, 45 feet below the surface, in the sand-beds below the bluff. These beds of sand are very extensively distributed over Missouri, Kansas, Nebraska and Iowa, and are called *altered drift* in my Geological Reports of Missouri and Kansas. I have not seen the locality, but think there can be no mistake about the geological position of the fossils. I judge from my knowledge of the country and Mr. Manning's very clear description of the strata passed through. I compared the teeth with others and could see no material difference between them and those of the living horse, save that they are rather larger than the usual size. The fossils are interesting in connection with the remains of the horse from the Post-pliocene, announced by Mr. Holmes, of Charleston, S. C., in 1848.

I am now at work on my collections of fossils made in Kansas during the past two years.

The line of division between the Permian and Carboniferous will remain where I put it in 1858. The evidence is incontestible. The Carboniferous fossils above that line are not so numerous, in comparison

with the Permian, as Maj. Hawn's collections seemed to indicate, and the lithological and stratigraphical evidences are too strong to be overlooked. The limestones change from an impure carbonate of lime to a carbonate of lime-and-magnesia; there is a want of conformity, and nearly all the well-marked Carboniferous types of animals cease; and only a few, such as are of doubtful specific relations, or have a very wide stratigraphical range, or such as come in high up in the Carboniferous series, range up through the lower Permian. I shall soon send you my preliminary Report.

4. *Evidence of a probable modern change of level on the coast of Florida;* by E. Lewis, Jr. (From a letter to J. D. Dana, dated Brooklyn, N. Y., March 24, 1866.)—While recently at St. Augustine, Florida,—at which place I have been on account of health,—I saw stumps of cedar trees which were covered with salt water at low tide; and on the beach fronting the town I observed that an ancient peat meadow lies *underneath* the Coquina formation in one place—the Coquina, or beach shell-rock, being solid enough for building purposes, and from 8 to 11 feet in thickness. How much or how far the peat extends beneath I cannot say; it lies as low as the level of *very low* water.

5. *Supplemental Notes on the Structure and Affinities of Eozoön Canadense;* by W. B. Carpenter, M.D., F.R.S.—In this paper Dr. Carpenter stated that a recent siliceous cast of *Amphistegina* from the Australian coast exhibited a perfect representation of the "asbestiform layer" which the author described in his former communication on the structure of *Eozoön*, and which led him to infer the Nummuline affinities of that ancient Foraminifer—a determination which has since been confirmed by Dr. Dawson. This "asbestiform layer" was then shown to exhibit in *Eozoön* a series of remarkable variations, which can be closely paralleled by those which exist in the course of the tubuli in the shells of existing Nummuline Foraminifera, and to be associated with a structure exactly similar to the lacunar spaces intervening between the outside of the proper walls of the chambers and the intermediate skeleton, by which they become overgrown, formerly inferred by the author to exist in *Calcarina*. Dr. Carpenter then combated the opinion advanced by Professor King and Dr. Rowney, in the preceding paper, and stated that even if the remarkable dendritic passages hollowed out in the calcareous layers, and the arrangements of the minerals in the Eozoic limestone, could be accounted for by inorganic agencies, there still remains the Nummuline structure of the chamber walls, to which, the author asserts, no parallel can be shown in any undoubted mineral product. In conclusion, the author stated that he had recently detected *Eozoön* in a specimen of Ophicalcite from Cesha Lipa, in Bohemia, in a specimen of gneiss from near Moldau, and in a specimen of serpentinous limestone sent to Sir Charles Lyell by Dr. Gümbel of Bavaria.—*Reader*, Feb. 10.

6. *Fossils of the Sierra Nevada.*—In the review of Whitney's Geology of California, on page 363 of this volume, it is stated that in January of 1864, Mr. King found Jurassic fossils on the Mariposa estate; and that this discovery was followed the same year by other discoveries by him and other persons. We add here that Prof. W. P. Blake, published a brief notice of fossils from the same region in the Proceedings of the California Academy of Sciences for October, 1864, vol. iii.

7. *Geological Sketches;* by L. AGASSIZ. 312 pp., 12mo, with a portrait and woodcuts. Boston, 1866. Ticknor & Fields.—This work has already been extensively read from the pages of the Atlantic Monthly, and admired for the simplicity and beauty of its style, the vividness of its descriptions of nature, and the grandeur of its views of the world's progress. Professor Agassiz reviews the prominent events of the successive eras in a manner that cannot fail to charm and instruct the most unscientific reader, and none can rise from the work without appreciating the reality of this progress, and being fully convinced, if not already debased by materialism, that there has been a system or plan in this progress, conceived in infinite wisdom, and sustained and carried forward at every step by a personal God.

While thus excellent in its aim and spirit, we are compelled to add that the work is not always a safe guide as to special facts or principles, owing to its oversights, or statements not accordant with observation.

Thus we find in the first chapter, on page 5, that water is the only substance which expands when freezing. On page 9, in the course of explanations on the metamorphism of rocks, or their alteration to the crystalline state, we read that sand is changed by heat to a coarse kind of glass,—when really it can make only baked or consolidated sand, or a sand-rock; also, that metamorphism is due to volcanic overflows or injections of melted matters,—when metamorphic rocks (gneiss, mica slate, etc.), occur where there are no volcanic overflows or injections, and such injections have at times, as in Canada, cut through even limestones without any alteration of the rock adjacent to the fissure. On page 15, we learn that the age of igneous rocks can be told by their crystals as easily as that of aqueous rocks by their fossils; on page 22, that the Azoic lands of North America are nowhere over 1500 feet in height,—when the Adirondacks of Northern New York exceed 5000 feet; on page 23, that the Laurentian mountains, the Azoic of Canada, are a granite range,—when the Canadian geologists assert that they contain no granite, but consist of gneiss, and allied metamorphic rocks, with some interstratified limestones; on page 25, that the metamorphic Azoic rocks have derived the larger part of the material of which they are made from marine volcanoes; and that there are "innumerable chimneys perforating the Azoic beds, narrow outlets of Plutonic rocks protruding through the earliest strata,"—while such "chimneys," or "funnels" for the ejection of granite as they are afterwards styled, have no place in the geological Reports of Canada, or of any other country.

Turning to the next chapter, we are told, on page 37, that the Silurian rocks are all of sea-beach orgin—when, in fact, geologists have distinguished that part were formed as immense sand flats, and part, including most of the limestones, as accumulations of organic origin over great shallow seas, and part may have been of deep-water origin. On the same page, and with more of detail on page 54, we are informed that fishes represented the subkingdom of Vertebrates among the very first living species of the globe, along with the earliest Crinoids, Mollusks, Trilobites, and Worms,—when no geologist has ever described any remains whatever of fossil fishes from the Primordial or earlier division of the Silurian—a division including, in some regions, thousands of feet of rocks representing an era one-third as long as the whole Silurian.

Again, in Chapter III, on page 69, we learn of an upheaval, "at the close of the Devonian age," which "raised the elevated ground on which Cincinnati now stands," and that "the force of the upheaval was such as to rend asunder the Devonian deposits, for we find them lying torn and broken about the base of the hill;"—when in fact this "Ohio hill," as it is called, is only an outcropping of the Lower Silurian, and the Silurian area spreads northward over 100 miles, before reaching the Devonian, and over 50 miles on the east and west, so that the "torn and broken" Devonian at its base is all fancy; moreover the decision that the uplift took place at the close of the Devonian age is not deducible from any facts yet observed. On page 75, it is stated that there were only sea-weeds in the Devonian age,—when New York long since afforded remains of Devonian ferns, and even of trees, and the Devonian of Maine and New Brunswick have more recently yielded numerous species of land plants, some of which Dr. Dawson refers to the *Conifers*, an order of plants which Prof. Agassiz says had no species even in the Carboniferous era. On pages 84, 86, the reader is informed that the genera *Productus* and *Goniatites* have no Devonian species,—when there are many known, a number of them American. On page 77, in speaking of the origin of the bitumen of our bituminous coals, he says, "Plants so *strongly bituminous as the Ferns*, when they equalled in size many of our present forest-trees, naturally made coal deposits of the most combustible quality;"—while, in truth, the Fern or Brake is known to be *never* bituminous, and, moreover, bitumen or petroleum may proceed, as has been abundantly proved, from the decomposition of plants of any kind, and also from animal matters, and has unquestionably been derived from both of these sources in the formation of different bitumen-bearing strata.

These specimens are sufficient without proceeding further. Such imperfections weaken the foundation of some of the arguments, and much impair the usefulness of the "Geological Sketches." When we read them in the Atlantic Monthly, several years ago, we could only suppose that the lectures on which they are founded were delivered without notes or much premeditation, and were intended rather for a vivid presentation of the grand argument than as an accurate exhibition of the facts on which that argument is built; and then, that the reporter's abstracts were sent to the periodical press without the careful revision which they needed, and which, in this collected form, they need all the more. The volume has as its frontispiece an admirable portrait of the author. The woodcuts are very poor.

8. *Geological Survey of Canada: Atlas of Maps and Sections, to accompany the Report of Progress from the commencement of the Survey to* 1863. 42 pp. with six maps, and several sections. Montreal, 1865. (Dawson Brothers.)—This atlas contains a detailed geological map of Canada, and of a portion of the United States, extending so far south as to include part of Virginia, much of Missouri, and west to the meridian of 100°. It is of unusual excellence in every respect, its exactness and beauty and distinctness of coloring being all that could be desired. Sir William E. Logan, through the Survey of Canada has thrown a vast deal of light upon the geology of the United States, and this map makes it available to all interested in the subject. In the extension of the map beyond the limits of Canada, he had the assistance of Prof. Hall, the

best authority in our country. There are some debatable points as to the distribution of the formations; as the limits of the Huronian, and of the Subcarboniferous; but such there must be as long as science is making progress. The other maps and the sections are also admirable in style and character.

9. *Contributions to the Paleontology of Illinois and other Western States;* by F. B. MEEK and A. H. WORTHEN. 20 pp. 8vo, (from the Proc Nat. Sci. Philad., 1865, 245.)—Mr. Worthen, who has had in charge the Geological Survey of Illinois, is now bringing out, with the aid of Mr. Meek forthe paleontology, the Reporton the geology of that State; and the article here issued is in part an abstract of a portion of that Report, the paleontology of which will be exceedingly rich in many departments. This paper contains descriptions of thirty-six new species of Mollusks, and of six of Trilobites, including one of *Dalmania* (Upper Silurian), one of *Lichas*, (Lower Sil.), one *Proetus* (Subcarbonif.), and three of *Phillipsia* (Subcarboniferous).

10. *Observations on the Microscopic Shell-structure of Spirifer cuspidatus* Sowerby, *and some similar forms;* by F. B. MEEK. 8 pp. 8vo. (From Proc. Nat. Sci. Philad., 1865, 275.)—Mr. Meek shows in this paper that the shell of the *Spirifer cuspidatus*, both of American specimens referred to this species, or closely related, and of an Irish specimen of this species received from Mr. Davidson, is clearly punctate, contrary to the decision of Dr. Carpenter. He then asks the question whether two types, a punctate having the internal characters of *Syringothyris*, and an impunctate, may not be included under the species, and suggests the importance of observations with reference to this question.

11. *Enumeration of Fossils collected in the Niagara Limestone at Chicago, Illinois, with descriptions of several new species*; by Prof. A. WINCHELL, and O. MARCY. 32 pp. 4to, with two lithogr. plates. From the Mem. read before the Bost. Soc. Nat. History, vol. I, No. 1.—This memoir treats of fossils of a limestone that had been referred by Mr. Worthen to the era of the Leclaire limestone, a conclusion sustained by the investigations here published. It also proves that the rock is of the age of the Niagara group of New York, but not necessarily of the upper part as had been suggested by Prof. Hall. The memoir closes with a note stating that Professor Hall has relinquished to the authors all claims upon two species described in it for which Mr. Hall had given names in a paper published, after the memoir had been read, in the Report of the Regents. Such an arrangement is bad for science as it sets aside the law of priority—which law must regard strictly time of publication.

12. *Mineralogische Notizen;* by F. HESSENBERG. No. 7. 46 pp. 4to, with 3 plates. Frankfort, 1866. (Christian Winter).—Contains excellent measurements and figures of Calcite from Iceland, Hessenbergite, Carnallite, Biotite from Vesuvius, Clinochlore of Zillerthal, Sphene, Titanite, Topaz, Gold, with an index to the seven memoirs which have been published.

13. *The Geology of Tennessee;* by J. M. SAFFORD, A.M. Part I. Physical Geography. 124 pp. 8vo. Nashville, Tennessee, 1861.—Professor Safford commenced the publication of his work on the Geology of Tennessee in 1861, but was compelled to suspend it by the war, after printing this introductory chapter, which only just now has been issued. It treats

very fully of the remarkable topography of the State. We trust that the geological survey and its publications will soon be resumed under Professor Safford. There is no one in the country better fitted for the work.

14. *A Catalogue of the Palæozoic Fossils of North America;* by B. F. SHUMARD, M.D. Part I, Echinodermata. St. Louis, 1866.—Our notice of this valuable work is unavoidably deferred.

15. *Professor Oppel's collection of Jurassic Fossils of Europe and Great Britain.*—By the recent death of Albert Oppel, Professor of Geology and Paleontology in the University of Munich, (of typhoid fever, at the age of 34 years, on the 23d of December last), it has become necessary to his family to sell his very large collection of fossils; all his little fortune having been spent on his education and his various geological journeys. We learn from Mr. Louis Sæmann of Paris (6 Rue de Mézières), who speaks highly of the collection, that it is offered for 10,000 Rhenish florins—4000 to 5000 dollars, and that it is well worth this sum.

III. BOTANY AND ZOOLOGY.

1. *Natural History Transactions and Journals*, considered by the President of the Linnæan Society.—Keeping up the excellent custom which he established upon his accession to the chair, of annually addressing the Linnæan Society, at some length, upon some important topic *apropos* to its pursuits, Mr. Bentham last year (at the Anniversary meeting, May 24, 1865,) took a survey of the Transactions and Proceedings of Learned Societies, and the Journals devoted to Natural History or containing zoological and botanical papers. Not pretending to give a complete bibliography, he nearly confines himself to the libraries of the Royal and Linnæan Societies, brought together at Burlington House. But still the subject is so extensive that, after filling over 60 pages of his printed address with an account of the continental publications of this sort, he is obliged to omit, almost wholly, those of Britain and of America, deferring them, as we trust, to another year. The account is replete with valuable information and excellent suggestions; and we are confident that we do good service to botanists and zoologists generally in directing their attention to a discourse of such practical interest. The latter part of the address discusses at some length the advantages and disadvantages of union or separation of sciences as pursued by learned societies, and in the publication of Transactions and Journals; as well as the different methods which have been proposed or adopted with the view of obviating or diminishing inconveniences and evils which are gravely felt. The Academy in early times embraced Science, Literature, and Art; but these have now, for the most part, been distributed to three separate bodies or branches.

"In the great centers of learning the division of labor has not stopped here. Moral and political sciences have almost universally formed either a distinct section of science, or an independent branch of learning between science and literature. Mathematical and Physical Sciences (Astronomy, Mathematics, Physics, and Chemistry), often associated with Natural History, and still in some Transactions and Journals even included in the general title of Naturkunde, Naturwissenschaften or Sciences Naturelles, have in other cases been quite separated. Geology

is the next to be cut off; and Zoology has parted with Botany; and lastly, independently of the numerous associations for the practical application of Natural Science, we have seen separate societies with their Transactions, as well as Journals, for Ornithology, Ichthyology, Entomology, Paleontology, Histology, &c. Men have thus been encouraged to restrict their observations to very limited classes of beings, and to generalize upon the very insufficient data thus obtained, with the same inconveniences which resulted at the outset from generalizing upon observations made in a limited territorial area. Reaction and an attempt at reconcentration have in some instances been the consequence; and it is now a great practical question, which has agitated many academical bodies, and which deserves our own serious consideration, how far we should connect or separate them in our meetings and publications."

On the one hand there is the impossibility, except in a few great capitals, of supporting several special societies, even if the division were most useful to science; on the other there is the great inconvenience of a mixture of physical, metaphysical, and biological papers in the same volume, and the hard fate to the botanist or zoologist of having to buy and to load his shelves with bulky volumes or sets for the sake of a few articles upon the subject he studies. A partial and the only obvious remedy for this,—one which has been generally acted on of late years by botanists at least,—is for the author to secure a reasonable number of extra copies of every considerable paper he contributes to a scientific association, for distribution among his distant fellow-workers, or when this is too expensive to place a small edition on sale. Every scientific society doubtless would, or should, favor this. The American Academy of Arts and Sciences formerly provided every contributor with 100 copies of his memoir, with a view to their immediate and gratuitous distribution among those who especially require them. It now gives 50 extra copies to the author, and retains an equal number from which to supply separate demands. And an author is allowed to print from the types as many more copies as he wishes, at the bare cost of press-work and paper. This Academy publishes memoirs upon all departments of science, and in the same volume or series; but the provision for detached copies is just as requisite in the case of societies which, like the Linnæan, are restricted to Zoology and Botany. Botanists cannot afford room nor purchase-money for zoological matter; and even the different departments of descriptive zoology are now almost independently pursued.

"With regard to the Transactions themselves," Mr. Bentham remarks that, with a view to larger usefulness, "various devices have been resorted to, by which those of the members who consider themselves as patrons or general cultivators of science could exhibit the whole on their tables and shelves as one complete work, whilst the laborers in science might select separate portions without the appearance of being fragments only. Separate volumes, series, parts of volumes, &c., have been devoted to the principal branches; or, again, every separate paper, however short, has its separate title and paging, although stitched up into volumes, with a general title: or a certain number of copies of each paper are printed off with a separate title and paging for separate sale. In some Continental Transactions the separate paging of short papers is carried

to such a degree as to entail all the inconveniences of a series of detached pamphlets. The double paging of the separate and of the continuous copies, on the other hand, produces much confusion in quoting references. The most convenient course pointed out by experience, seems to be that, in quarto Transactions including a diversity of subjects, the papers should be separable; but that each should bear an indication of the Transactions and volume from which it is taken; retaining at the same time the original paging in all separate issues, whether of authors' copies or for sale." Where the memoirs truly constitute volumes, it is far better, we think, that the paging should continue unbroken through the volumes. In the Smithsonian Contributions, to be sure, the papers are separately paged; but their collection into volumes is in this case rather incidental. In any case, not only should the original paging of a memoir be retained in the separately issued copies, but they should bear no other. Double paging is very troublesome in reference.

We would further suggest to authors the great convenience to citation and reference of what may be called *catch-titles* to papers of descriptive botany or zoology, consisting of a prominent word or two, by which the paper may be succinctly referred to.

In conclusion we note that the President of the Linnæan Society, having formerly employed the word *biology* in the sense nearly of physiology, now, following the recent lead of the British Association, uses it in the sense of zoology and botany (in their widest sense) combined. *Natural History* (an unfortunately-chosen word in the first instance) includes at least mineralogy, and *natural-historical* is an unmanagable adjective, *Biology* and *biological* are appropriate words in this sense, and supply just what is much wanted. A. G.

2. *Flora Brasiliensis.*—A new issue of von Martius's great work, dated Dec. 1865, consists of fasc. 39 and 40, accompanied by Table of Contents and Order of arrangement of the Monographs of the forty *fasciculi* now published, with an Index of the Genera, &c. In fasc. 39, that excellent collaborator Dr. Eichler, in continuation of fasc. 38, gives the *Capparideæ*, *Cruciferæ*, *Papaveraceæ*, and *Fumariaceæ*, the last two orders comprising each only a single species naturalized in Brazil. They serve, however, to introduce, 1st, a note in which Dr. Eichler, with good reason excludes *Tovaria* from the *Capparideæ* and refers it to the *Papaveraceæ*, and 2d, a dissertation upon the morphology of the flower of *Fumariaceæ*, &c., of which we give a separate abstract. There is a full synopsis of all the South American species of *Cleome* and of *Capparis*, newly arranged. Fourteen plates illustrate the first two orders. In fasc. 40, the veteran editor gives an article on the uses of the *Apocynaceæ*, of which the most interesting item is the account of the new tonic febrifuge furnished by the bark of *Geissospermum Vellosii;* and a new collaborator, Dr. Progel, contributes the *Gentianaceæ*. A. G.

3. *Morphology of the Androœcium in Fumariaceæ.*—In his *Excursus Morphologicus*, above mentioned, Dr. Eichler enumerates five different theories, which have been proposed in explanation of the peculiarities of the Fumariaceous flower, viz: that of De Candolle, the earliest, that of Bernhardi, that of Gay, and the same as improved by Krause, and that of A. Gray. Neither Bernhardi's nor Gay's view would now be likely

to engage attention; and the question is narrowed down to the two remaining, the first and the latest proposed. The difference relates to the stamens only. In the Candollean hypothesis, which has been generally received, the six stamens present in *Fumaria*, *Dicentra*, &c., are reckoned as four, one before each petal, the stamen which belongs before each inner petal being supposed to be divided into two half-stamens, and so separated as to be placed before the outer petals, one on each side of the unaltered stamen, and usually combined with it into a triantheriferous filament. According to the other view, the six stamens answer to two, viz, those of the first stamineal circle, and the augmentation by which three appear in the place of one was referred to *deduplication*, more properly termed *chorisis*, the suggested analogy being that of a trifoliolate leaf. In the original statement, the writer ventured to "presume that the lateral stamens would be found to arise" thus. Several years later this was confirmed by the late M. Payer, by observation of the development of the androecium. Equally were the three stamens of the phalanx found to originate from one semilunar protuberance, before an outer petal, by Dr. Rothrock, then a botanical student at Harvard University. His observations were published in the summer of 1863, in the Proceedings of the Boston Society of Natural History, ix, p. 246. Dr. Eichler, in the recent number of the *Flora Brasiliensis*, also in the Regensburg *Flora*, has demonstrated this anew, and illustrated the common origin of the three members of the phalanx in a manner which would appear to be conclusive. Moreover, since the commencement of the present year, Dr. Buchenau of Bremen has published in the *Flora* his observations upon the development of the flower of *Fumaria officinalis*, with figures, clearly showing the same thing. The supposition of the common origin of each set, which the symmetry and structure of the blossom naturally suggested, having been confirmed by four independent investigators, must be held as established, until called in question by other direct observations. Dr. Eichler intimates that the view which he confirms was originally imperfect in not explaining why the carpels stand opposite the stamineal phalanx. But it was, perhaps, sufficiently obvious that the second circle of two stamens, necessary to complete the full symmetry of the flower, was suppressed. In one of his figures, illustrating the formation of the androecium in a *Corydalis*, Dr. Eichler exhibits a slight protuberance before each inner petal, answering to the second set of stamens, but which never develops farther. Dr. Eichler's next point is very neatly made. He wishes to explain why the lateral stamens should have only unilocular anthers. The analogy of a trifoliolate leaf is here at a loss. But Dr. Eichler ingeniously supposes the lateral stamens to be homologous to the stipules of the stamineal leaf; and each lateral stipule, being a dimidiate organ, may be expected when antherimorphous to give rise to a dimidiate anther. We had paid no regard to *Hypecoum;* but we should have inferred that the normal bilocular stamen before each inner petal represented the second dimerous verticil of the androecium, which is suppressed in the rest of the order. But Eichler, like Payer (both without sufficient exemplification of the process of development), consider them to be here formed by the confluence of the lateral unilocular (or stipular) stamens on each side into one bilocular stamen.

The Cruciferous flower is illustrated by Eichler in detail, and is explained as dimerous throughout (as in *Fumariaceæ*), except as to the corolla, which is tetramerous and diagonally cruciate, the petals therefore alternating with the sepals; the stamens as belonging to two binary verticils: first, the short ones which are lateral, second, the two median pairs, each representing a single one divided into a pair by chorisis. The sole peculiarity of this view is in regarding the flower as binary rather than tetramerous in plan, with a remarkable exception at one verticil (which however, is not unparalled); and it has the advantage of completely homologizing the Cruciferous with the Fumariaceous flower, and of explaining the lower position of the shorter stamens; and the evolution of the stamens is said accord with this view, while it demonstrates the common origin of the members of the pairs of longer stamens. The polyandry of two species of *Megacarpæa* is of course attributed to chorisis. And the Capparideous flower, in the *Cleome* tribe, follows the same rule, only with more frequent increase of the median set of stamens, and sometimes of the lateral stamens also, as Dr. Eichler's observations upon the organogeny of *Polanisia* appear to show. We presume that Dr. Eichler's observations may be thoroughly relied upon; and his exposition is especially clear and neat. A. G.

4. *Flora Vitiensis: a Description of the plants of the Viti or Fiji Islands, with an account of their History, Uses, and Properties;* by Berthold Seemann, Ph.D., F.L.S., F.R.G.S., &c. London: Lovell Reeve & Co. Parts I–III, 4to; plates 1–30, including a map of the islands, and a pictorial view. 1865.—Dr. Seemann, a German botanist naturalized in England, was in the Pacific twenty years ago as botanist in the cruise of the Herald, the results of which were published in a fine 4to. volume. A few years ago, when *Ebenezer Thakombau*, one of the chiefs and self styled king of the Feejee Islands, proposed to cede these islands to Great Britain, and Col. Smythe was commissioned to visit them and investigate their condition, Dr. Seemann was appointed to accompany him and to report upon their vegetable productions and resources (see this Journal, vol. xxxv, p. 446). The collection of plants made during this investigation, is the basis of the materials of the present Flora, to which several smaller collections, made during the visit of surveying vessels under Belcher, Denham, and Howe, and later by Dr. Seemann's former assistant Mr. Storck, have also contributed. The more extensive collection made in the U. S. South Sea Exploring Expedition under Commodore Wilkes, has not come directly under the author's survey, although many specimens are in the Kew herbarium. The work is to be comprised in ten parts, each of 40 pages of letter-press and 10 colored plates, all in the excellent style which characterizes the late Mr. Reeve's scientific publications; the materials elaborated with Dr. Seemann's accustomed care and ability, and the drawings from the pencil of Walter Fitch. The pages of the volume are enriched with those personal observations of the author upon the living plants, or their useful products, which give to such a work peculiar value; also by appended monographs or sketches of other Polynesian plants. The third part, issued at the beginning of the present year, nearly completes the *Polypetalæ*. We cannot here venture upon any of the numerous remarks

which this work naturally suggests to one who has written almost all that had heretofore appeared upon the phænogamous botany of the Feejee Islands. Much that is new and interesting is brought to light by Dr. Seemann; and still more doubtless remains. An enumeration of the plants figured would naturally include the most interesting accessions. They are a new *Polyalthia; Hibiscus Storckii*, too near *H. Rosa-Sinensis; Pimia rhamnoides*, a new genus allied to *Commersonia; Græffia calyculata*, a new Tiliaceous genus; two new species of *Elæocarpus*, one of them (*E. Storckii*) with strikingly large and showy, bright red flowers; *Calysaccion tinctorium*; *Pometia pinnata*, Forst; *Smythea Pacifica*, a new Rhamnaceous genus, different from Ventilago in its samaroid dehiscent fruit; *Stemonurus Vitiensis; Storckiella Vitiensis*, a remarkable new genus allied to *Cassia; Serianthes myriadenia* of Planchon; *Eugenia gracilipes*, A. Gray, and *E. Grayi*, n. sp.; a new species of *Spiræanthemum*, A. Gray; *Nothopanax multijugum* (*Paratropia*, A. Gray); *Nesopanax* and *Bakerai*, both new Araliaceous genera; the latter 14-androus, the former polyandrous, like the next, viz. *Plerandra*, of which a second species is here figured; a new *Loranthus* and a new *Lindenia*, both showy; a third *Dolicholobium*, but too like one of the old species; *Gardenia Vitiensis; Blumea Milnei; Paphia Vitiensis*, a very showy-flowered new Vaccineous genus; *Ardisia grandis;* and a charming new Apocynaceous plant *Carruthersia scandens*, evidently named for the excellent assistant Curator of Botany at the British Museum. The letter-press of the later plates not yet published. Dr. Seemann here, as well as in his Journal, propounds his novel view that the distinguishing difference between *Araliaceæ* and *Umbelliferæ* lies in the valvate corolla of the former. Æstivation gives valuable characters, especially for genera; but it will hardly be found stable or deemed important enough to transfer *Hydrotyle* to *Araliaceæ* and *Aralia* itself to *Umbelliferæ*, as Dr. Seemann proposes. A. G.

5. *Botany of Australia.*—While the *Flora Australiensis* is steadily advancing, partly through materials and notes forwarded to Kew by Dr. Müller, the labors of the latter in Australia do not flag, and the Colonial Government of Victoria is as active and liberal as ever in promoting publication. We have now before us the following recent volumes of Dr. Müller's publications:

Fragmenta Phytographiæ Australiæ, the fourth volume, 1863–4, with numerous plates, 8vo.

The Plants indigenous to the Colony of Victoria, a second volume, entirely of "Lithograms" with explanatory letter-press, carrying on the plates from 13 to 71, besides 7 supplementary plates, royal 4to, 1864–65. The analyses are very full, the drawing excellent, and the lithography would do credit to almost any country. The descriptive letter-press is deferred to give precedence to the corresponding volumes of the *Flora Australiensis*, which these plates will fittingly illustrate. A. G.

6. *Analytical Drawings of Australian Mosses;* edited by Ferd. Müller. Fascicle I. 8vo. 1865. Twenty plates, with brief explanations of the figures.—The species illustrated have been published by Dr. Hampe of Blankenburg (Brunswick), and the illustrations drawn under Dr. Carl Müller's care, at Berlin, but lithographed and printed at Melbourne. The plates are remarkably good, the typography beautiful.

7. *The Vegetation of the Chatham Islands, sketched by Ferdinand Müller.* Melbourne, 1865. 86 pages and 7 plates.—"If under any circumstances a deep interest is attached to isolated islands, which harbor perhaps the only remnant of the vegetation or animal life of countries ages ago sunk beneath the ocean, this interest cannot be otherwise than most vividly excited in regard to the Chatham Islands, inasmuch as this little group is the last eastward of New Zealand, no further land existing under those latitudes in the wide interjacent oceanic space until the west coast of South America is reached." They had been visited by Dr. Dieffenbach and others. But the present exploration was made by Mr. Henry H. Travers, at the expense of his father, Judge Travers of Canterbury, New Zealand, to whom this interesting little book is dedicated. Of the 129 indigenous species of plants here enumerated and discussed 42 are dicotyledonous, 20 monocotyledonous, and 67 cryptogamous. Only 9 phanerogamous species are peculiar to the group, and one (*Myosotidium nobile*) generically peculiar; nearly all the rest are found in New Zealand, as was to be expected. In the limitation of species, Dr. Müller takes very comprehensive views, as is exemplified in the reduction of nearly a dozen New Zealand *Epilobia*, admitted even by Dr. Hooker as probable species, to *E. tetragonum* of Europe. At the same time he reiterates the expression of his entire confidence in the real objective distinctness and permanent stability of genuine species, insisting that their perfect discrimination is far from hopeless, and that their true distinction never rests on solitary or on faint characters or upon such as admit of exceptions! We admire this hopeful spirit, especially in a botanist of such large experience.

In the conclusion of his preface, Dr. Müller appeals to missionaries, as enjoying unparalleled facilities for scientific researches in lands mainly occupied by savages; and, rendering due acknowledgements for what has already been done by them, adds that, "if the devoted men who carry abroad the *word of God* were more generally cognizant how often it is alone as yet in their power to reveal also many of the marvellous *works of God*,—of which no spot, however desolate and lonely is devoid,—the universal history of nature would be much earlier written, and on the divine labors of the mission throughout the globe would be shed an additional brilliant lustre." A. G.

8. *Revision of the genus Cousinia. Uebers. Zusammenstellung der Arten der Gattung Cousinia Cass.;* von Dr. Al. Bunge.—One of the Memoirs (now separately printed) of the Imperial Academy of Sciences of St. Petersburgh, issued 1865: the preface in German; the systematic part wholly in Latin. The Oriental Thistle-like genus which Cassini dedicated to the philosopher Cousin, founding it on a single species, increased by DeCandolle, thirty years ago, to thirty-four species, is now in Professor Bunge's systematic revision augmented to 126 species. It is the prominent and characteristic genus of the Assyrian and Caspian region. A. G.

9. *Krok, Monograph of Valerianeæ.* Part I, *Valerianella.* From the Roy. Swedish Acad. Sciences of Stockholm. 1864, pp. 102, with 4 plates of analyses, large 4to.—The prefatory matter is Swedish; but all the systematic part in Latin. An elaborate monograph of *Valerianella*, kept

distinct from *Fedia:* 47 species are described, arranged under five main sections, the fifth, *Siphonella*, Torr. & Gray, being acknowledged as wholly intermediate between *Valerianella* and *Fedia*. Analytical illustrations are given in the plates of all the species, except the rare *V. Nuttallii*, which is probably only a state of *V. longiflora*. A. G.

10. *Scolopendrium officinarum*, the Hart's-Tongue Fern of Europe, was first made known as an American plant by Pursh, in his *Flora*, 1814, who records it as growing "in shady woods, among loose rocks, in the western parts of New York, near Onondaga, on the plantations of J. Geddis, Esq. This species I have seen in no other place but that here mentioned, neither have I had any information of its having been found in any other part of North America." Nuttall, indeed, in his Genera, 1818, gives the habitat, "In the western parts of the State of New York, in the crevices of calcareous rocks, beneath the shade of the Hemlock Spruce (*Abies Canadensis*) and accompanying the *Taxus Canadensis* or American Yew;" his appended *v. v.* implying that he had himself seen it alive. No specimen of his is extant; but from some source, not now recollected, it would appear that his station was "near Canandaigua," which is nearly one hundred miles west of Onondaga. Between 30 and 40 years ago, the late William Cooper discovered the locality at Chittenango Falls, 20 or 30 miles east of Onondaga; and this has remained the only really known station of the plant in North America, until the recent discovery of another (in 1857) at Owen Sound on Lake Simcoe, by Prof. Hincks of Toronto.

We have now to announce the fortunate discovery of a new station in the United States,—one which, if it be not the very locality of Pursh's original discovery, cannot be far from it, being within a few miles of Onondaga, and upon ground which in Pursh's time must have been included in that township. The discovery was made, in March last, by Lewis Foote, Esq., of Detroit, in the township of DeWitt, upon the line of the Syracuse and Binghamton Railroad, about five miles from Syracuse. It was found in a deep rocky ravine, where, upon a hasty survey, it seemed to be plentiful. We are indebted to the lucky discoverer for a dried specimen. A. G.

11. *Musci Boreali-Americani, sive Specimina Exsiccata Muscorum in Americæ Republicis Fœderatis detectorum; conjunctis studiis* W. S. Sullivant et L. Lesquereux. Editio Secunda. Columbi Ohioensium, sumptibus Auctorum, 1865.—The first edition of this most important collection was issued ten years ago, and the sets were almost immediately taken up, as they well might be. For their actual cost—thanks to Mr. Sullivant's liberality and strong desire to encourage a favorite study—was fully twice the price at which they were offered. An account of the work will be found in this Journal for May, 1857, vol. xxiii, new series, p. 438. To this notice we would refer those interested in Muscology, remarking that the statements there made are equally true (*mutatis mutandis*) of the second edition now before us. This bears the date of 1865, the tickets and other letter-press having been printed a year ago. But the sets are only now issued (April, 1866), other engagements having prevented Mr. Lesquereux from giving his whole time during the past year to completing their preparation, which has been a long

and severe undertaking, requiring the microscopical examination of an immense number of specimens, and the patient selection and distribution of the elaborated materials by which each set is made so complete.

This new issue is not a mere reproduction of the former, but is much augmented. While that contained a little over 400 species or marked varieties, this contains 536. Those of the old tickets which are unchanged are reprinted with a new sequence of numbers, which was unavoidable in order to bring the new accessions into their proper places. The novelties which enrich these sets are partly Californian, contributed mainly by the zealous Bolander; partly from the Rocky Mountains, by Mr. E. Hall, and many new eastern species, which have been detected by Messrs. James, Peck, Austin, Clinton and Ingraham, as well as by Mr. Lesquereux himself. A few of these are necessarily rather scantily represented; but the specimens are usually very abundant and choice. In this as in other respects the work is, so far as we know, wholly unrivalled. From data known to us we estimate that the present issue has cost fully $100 per set or copy. They are sold at $35 in gold, or £7 sterling, or 175 francs. Each copy is accompanied by an 8vo pamphlet of 96 pages, being a reprint, in convenient form, of all the tickets, characters of new forms, and index. Applicants will address Mr. Leo Lesquereux, at Columbus, Ohio. A. G.

12. *Mind in Nature or the Origin of Life and the Mode of Development of Animals;* by Prof. H. J. Clark.—A brief notice of this book appeared in the last number of this Journal, indicating the nature of the work, and some of the leading subjects discussed. To present an adequate review would require a more extended article than is consistent with the space allotted in this Journal.

The first five chapters are devoted chiefly to discussions of the various modes of reproduction and increase among animals, and the analogous phenomena of the regeneration of lost parts, and the persistence of "vitality" in decomposing tissues.

In the first chapter the curious structure and habits of the lowest Rhizopods, *Amœba*, *Difflugia*, &c., are very clearly presented, showing that even in these, the simplest of animals, the functions of prehension, digestion, circulation, locomotion, and a certain kind of nervous sense exist, even while the whole organism apparently consists merely of a minute drop of semi-fluid matter without walls or definite form.

The subject of spontaneous generation is then discussed, and the recent interesting experiments of Prof. J. Wyman are brought forward to prove that this manner or origin of life is one in actual operation.

From those experiments, published in this Journal, July, 1862, he draws conclusions far broader than their author felt justified in doing, and which do not appear to us logical, even if the spontaneous origin of these low forms of life be admitted. On this point remarks have been made by Professor Dana, on page 286. It seems premature, at least, to consider spontaneous generation as actually established by such experiments. If this be the true explanation of the phenomena, why should not the living forms have appeared equally in *all* the flasks? for in some cases they did not appear at all, while in other similar ones they appeared in great numbers. Admitting that the treatment was such as to have utterly destroyed

all germs existing in the fluids, and the air admitted into the flasks, can it be said that we know enough about the physical structure and porosity of glass to say that the germs of these almost infinitely minute organisms may not even penetrate its substance? Physicists claim and experiments prove the porosity of all solid bodies, and we do not yet know the limits to the minuteness of animate beings or their germs.

In this connection it should not be forgotten that the power of the best microscopes is limited, and that objects of less than a determinable size, are still invisible. Lines ruled on glass by mechanical means, cease to be resolvable by the best lenses when the distance between them approaches ·00001 of an inch, and there is no good reason to suppose that living germs may not exist far more minute than this.

We have dwelt upon these sources of doubt with regard to such experiments because the leading arguments of the first part of Prof. Clark's work are based almost wholly upon the results of Prof. Wyman's experiments. We would not be understood as asserting that the spontaneous origin of living beings under such circumstances is impossible; but only that we need additional evidence.

Among the most interesting portions of the work are the explanations of the origin and early condition of ovarian eggs, and the changes they undergo as development proceeds. The egg considered as the lowest condition of animal life is shown to consist at first of a mere spherical aggregation of albuminous and oily matters, like a simple cell, but with a bipolar character, i. e. the albumen concentrates at one side of the spherical mass, and the more oily portion of the yolk on the opposite side. While the eggs of Infusoria never attain a more complicated structure than this; in those of higher animals a further change takes place resulting in the formation of the so-called germinal vesicle and germinal dot, which is to be considered only a continuation of the process commencing with the imperfect separation of the albumen from the oily portion in the lowest form of the egg, the difference being only in degree and not in kind. The egg is regarded as an *animal* from the first, but comparable only to the lowest forms of infusorial life. The continued development of the egg or embryo is shown to depend more or less upon secondary causes,—most so among the lowest animals,—and in this respect a comparison is made with those germ-like forms supposed to originate and develop *wholly* through secondary causes.

In this connection the structure of various Infusoria is finely illustrated, and the gradual advance in organization from *Amœba* and similar forms, through sponges, *Actinophrys*, *Polycystinæ*, *Zoöteira* and *Podophrya* upward to the higher Infusoria, is well shown; the object being to show the parallelism between the development of the egg and the zoölogical series, and that there is "no sudden transition from the *condition of an egg* to that of *an animal*." The change induced in the ovarian egg by *fecundation*, without which the egg, in general, cannot develop beyond a certain point, and has no independent life, is apparently not regarded as of so vital importance by Prof. Clark as by most writers, very little being said concerning it. To us this would appear to be the starting point of the new being as an independent existence, rather than the formation of the ovarian egg.

The third and fourth chapters, devoted to the phenomena of reproduction by budding, and by fissiparity, with the curious experiments in artificial division and grafting of Hydra, &c., cannot fail to interest every one. It is accompanied also by lucid descriptions and beautiful figures of Actiniæ, Stentor, Acalephs, such as Hydra, Aurelia, Coryne and Rhizogeton, the tape-worm, Myrianida, &c., which are seldom equalled in popular works. The author well illustrates reproduction without eggs, so well known among the lower animals, as accessory to ovarian generation; but these phenomena do not appear to us to lead any nearer to *spontaneous generation*, for in all cases a parent is necessary to vitalize the separated part, however minute it may be, and we cannot agree with him in comparing artificial division to "decomposition," either in the case of the *Hydra*, *Planaria* or *Amœba*. The latter "may be divided, and even divides itself, more minutely than the Hydra allows; in fact there is no conceivable limit to the minuteness with which it may be cut up," "and yet each subdivision moves and seizes its prey just as does the main stock from which it was separated."

The somewhat analogous phenomena observed several years since by Prof. Clark, in the muscular fibres of Sagitta, sheep, &c., and the ciliated cells of Aurelia, which separate during decomposition of the tissue and move about freely like low forms of Infusoria, are fully described in this connection, and the theory of the spontaneous origin of life in decaying matters is thus reinforced. Could it be shown that any of these detached and moving cells continue to live and either reproduce themselves or develop into any higher forms, the origin of life in the sealed flasks would be really accounted for. Otherwise we cannot agree with the author that "Amœba (and Rhizopoda in general) in one sense a one-celled animal, has scarcely a higher state of vitality than the decomposed sheep-muscle, or Aurelia-cells," (p. 99). Nor can we agree with him in comparing to the decomposing matter in the flasks an undeveloped hen's egg, depending though it may for its development upon heat and air, just as the hatched chick depends upon the same physical causes for continued life and growth, even if "not acted upon by this physical agent, *heat*, it would remain in a low state of vitality, perhaps as low as any decomposing muscle or tendon, and finally it would decay."

The statement that "in the *egg* we have an *uncomposed* substance, and in the decaying muscle we have an animal *returning* to its former *uncomposed* state," certainly does not do justice to the vital principle, latent though it may be, that exists in the egg and only needs the stimulus of heat and oxygen to give rise to the complicated organization of the chick. Nor does it agree with the author's previous statement (see p. 52) that "an egg is not to be looked upon as a distinct *body* which *preëxists* the animal, but rather that it is *the animal itself*, from the moment when it begins to form in the ovary of the parent." "The egg is merely the *first stage of growth of an animal*, and it is not separated from the succeeding phases any more than these latter are from each other." Certainly the condition and fundamental nature of the *egg*, cannot in any sense, be correctly compared to decomposing muscle.

The processes of digesting food and changing it into the living tissues of the body, whether of man or Amœba, is compared to the assumed

change of decomposing organic matter in the sealed flasks to living organisms, and the question is asked, "why may not different kinds of animals arise from any decomposed matter?" If the vital force or life-giving principle, whatever it may be, can be shown to exist in such decaying matter, the origin of the organisms could be as readily understood as are the changes of dead food into the living body, under the influence of the vital forces, in the processes of digestion and nutrition. Until then we cannot admit that the comparison is a logical one. The discussion of the *primordial* condition of animals, or the condition in which they were *originally created*, whether in the egg or adult state, is one which may well excite attention, but which we will not here attempt to consider.

Part Second of the work is devoted to a consideration of the structure, relations, and classification of animals, and abounds with excellent descriptions and illustrations of the structure of species from the various classes, and is a very valuable addition to the few popular American works upon the structure of the lower animals. The portions relating to Infusoria and the lowest forms of other groups are particularly valuable. Most of the very excellent illustrations in this, as in other parts of the work, are original, and many are new. The author here adopts the four grand divisions of Cuvier, with modifications, and with many others believes that the Protozoa constitute a *fifth* division, as distinct from the others as those are among themselves, but he regards them as merging gradually into each other, as clouds that touch and mingle somewhat at their borders. The bipolar relations in the organization of all animals, and the *bilaterality* which is equally a fundamental feature of all, are well brought out and illustrated, and it is shown that this is as characteristic of *Radiata* as of the higher groups, and it is claimed, beyond doubt justly, that the more or less radiated appearance is subordinate to bilaterality.

Two chapters are devoted to an examination of various forms of the lower ciliated Infusoria, and to comparisons between them and low vegetable forms, ciliated plant-spores, &c. The *Volvox* is not neglected in this connection, and is left, as it were, suspended between the animal kingdom on one side and the vegetable kingdom on the other. Several new forms are described and figured, and much valuable information added to our knowledge of these beings.

A chapter is devoted to the structural features and characteristics of each of the five great groups, and in each there is much valuable and interesting matter, and many original contributions. The anatomy of Epistylis, Paramecium, Pleuronema, Dysteria, among Infusoria; Metridium and Cereus, Caudina and Asteracanthion among Radiata; Pectinatella, Fredricella, Ostrea, Helix and Loligopsis of Mollusca; is in each case illustrated by original figures and descriptions. The excellent figure (117) given as *Psolus phantapus* seems to us to represent rather *Cuvieria squamata* D. & K. as we have observed it when fully expanded in its native haunts. Possibly an error in the identification of the species has occurred here, but for the author's purpose either form would serve equally well.

The characteristic feature of Protozoa is stated to be *spirality* or *obliquity*, superimposed upon bilaterality. It would seem, however, to be

a question whether spirality is not characteristic of *all life*, whether animal or vegetable, and is only more apparent in the Protozoa because not obscured, as in higher animals, by various other relations. The Zoöphyta (Radiata) are said to have "a type of organization in which the various organs repeat themselves, more or less, between the back and the abdominal mid-line of the body; that is to say, they are *laterally repetitive* on each side of an imaginary plane which divides the body exactly into right and left halves." This definition expresses the true relation of parts very accurately. We have hitherto employed a similar one in class lectures,—namely: that the type is characterized by the repetition of similar longitudinal segments or *homologous elements* on the two sides of a longitudinal plane, while in Articulates homologous elements of a different kind are repeated serially along the longitudinal axis.

The idea is precisely the same in each case. The Mollusca are compared in a similar way to the other groups thus:—"The Zoöphytes are from back to front, dorso-ventrally, polymerous; the Articulata are from tail to head uro-cephally, polymerous; and the Mollusca are *monomerous*."

By a detailed comparison between Protozoa and Zoöphyta, Protozoa and Mollusca, Protozoa and Articulata, Zoöphyta and Articulata, and Bryozoa and Zoöphyta, it is shown that there are no actual transitions from one of the five great divisions to another. Some of the curious mimetic forms and embryonic resemblances are illustrated, and in a later chapter some forms, considered as transitions from one *class* to another within the great groups, are described.

The third part of the book is devoted to a brief account of the development from the egg of various kinds of animals. It is here shown that each of the five great divisions has a distinct and characteristic mode of development and growth. The embryology of Podophrya, Paramecium and Stentor illustrates the process in Protozoa; Actinia and Holothuria in Zoöphyta; Lymnæa in Mollusca; Mystacides in Articulata; and Chelydra serpentina in Vertebrata. In connection with the latter the author, as in other parts of the work, lays personal claim to investigations made for and published in Agassiz's Contributions to the Natural History of the United States.

However much other naturalists may differ from our author in many details, and in his generalizations and conclusions, the work cannot but be welcome to every one who, in seeking the truth, desires to see every side of these questions fully and fairly discussed. In no other way can we hope ever to attain the fundamental truths in nature. A. E. V.

13. *The Urine in Health and Disease*, being an exposition of the composition of the Urine, and of the pathology and treatment of urinary and venal disorders; by ARTHUR HILL HASSALL, M.D., Senior Physician of the Royal Free Hospital, etc. 2d ed., 416 pp. 12mo, with numerous engravings. London, 1863 (John Churchill & Sons).—A thorough and complete work on the urine, illustrated by numerous beautiful drawings representing the crystallizations of urinary deposits, tissues, etc., as observed in the field of the microscope.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *National Academy of Sciences.*—The National Academy of Sciences commenced its semi-annual session in Washington, D. C., on the 24th of January last.

The following are the titles of the communications presented during the session:

"On the silver reduction process of Nevada, with statistical tables and metallurgical data, by Prof. B. SILLIMAN."

"On a new general method of volumetric analysis, by Prof. W. GIBBS."

"On sodium amalgam and its applications in saving precious metals, especially gold, by Prof. B. SILLIMAN."

"On the limits and character of the vision of American Soldiers as deduced by the Statistical Department of the Sanitary Commission, by Dr. B. A. GOULD."

"On the primary triangulation of the Coast of New England, by Prof. A. D. BACHE, Superintendent U. S. Coast Survey; communicated by J. E. HILGARD.

"On the relation of Language to Ethnology, by Prof. W. D. WHITNEY."

"On certain mineral districts of Arizona, by Prof. B. SILLIMAN."

"On California petroleum and the products of its distillation, by Prof. B. SILLIMAN."

"Observations on the Annular Eclipse of October, 1865, made at Lebanon, Ill., by Prof. STEPHEN ALEXANDER."

Biographical memoirs of deceased members of the Academy were read as follows: Of the late General Joseph G. Totten, Chief Engineer U. S. Army, by Gen. J. G. Barnard; of the late Prof. Benjamin Silliman, by Prof. Alexis Caswell; of the late Capt. James M. Gilliss, U. S. Navy, Supt. Naval Observatory, by Dr. B. A. Gould.

The office of Vice-president, made vacant by the resignation of Professor Dana (in consequence of the state of his health) was filled by the election of Prof. Henry.

Of the Committees appointed at the request of Departments of the Government to conduct certain investigations, that on Magnetic Deviations in Iron Ships, and that on Experiments in working steam expansively, reported progress.

The Committee on Uniform weights, measures, and coinage, made the following report, which was adopted by the Academy, and ordered to be communicated to the Treasury Department and to the Congressional Committee having charge of the same subject:

"The Committee are in favor of adopting ultimately a decimal system, and in their opinion the metrical system of weights and measures, though not without defects, is, all things considered, the best in use.

The Committee therefore suggest that the Academy recommend to Congress to authorize and encourage by law the introduction and use of the metrical system of weights and measures; and, with a view to familiarize the people with the system, the Academy recommend that provision be made by law for the immediate manufacture and distribution to the Custom Houses and States of metrical standards of weights and measures; to introduce the system into the post offices, by making a single letter weigh fifteen grams, instead of fourteen and seventeen hundredths, or half an ounce; and to cause the new cent and two cent pieces to be so coined that they shall weigh respectively five and ten grams, and that their diameters shall be made to bear a determinate and simple ratio to the metrical unit of length."

The next session of the Academy will be held at Northampton, Mass., commencing on the 7th of August.

2. *Note on Illumination of opake objects under the Microscope;* by H. L. Smith, Kenyon College.—In several scientific Journals of England, the little contrivance first described by me in the September No. of this Journal, 1865, is noticed and variously commented upon. With an apparent unwillingness to acknowledge any merit outside of themselves, the writers of these notices have dwelt especially upon certain *fancied* improvements, made by Messrs. Powell & Leland and Smith Beck & Beck, as the really valuable parts of the invention. Especially is this the case with the slight notice in the January number of the "Quarterly Journal of Microscopical Science," and the more extended one in the January number of the "Intellectual Observer," where the substitution of a glass plate for the metallic reflector, is spoken of in the highest terms. Now if my article had been read, these writers would have seen that this substitute had been tried, and abandoned by me. Even if it *is* an improvement and I have misjudged, still it is not original with the celebrated opticians who are so lauded for the invention. It is not true, as stated in the notice which is quoted from the "Reader" in the last number of this Journal, p. 283, that the metallic reflector cuts off half the pencil; an assertion which is also made in the "Microscopical Journal." Less than one-third, is amply sufficient to give a much stronger illumination than the whole of the glass substitute proposed; and with this great advantage, that the fog, or glare, which attends central illumination, may all be eliminated; and, upon diatoms especially, a vastly superior illumination may be obtained. The improved "Illuminators" are now furnished with an extra movable diaphragm above the illuminating reflector, which, although it diminishes the angle somewhat, greatly improves the definition, by prevention of irradiation when the object is very brilliant; it leaves however the whole angle effective for illumination. I certainly would be the last one to object to any *real* improvement which the English opticians might make; but do protest against being entirely ignored, as in the number of the "Microscopical Journal" for January, 1866, where a contrivance, already described by me, is so carefully alluded to, that no one would for a moment suppose that any credit was due except to Messrs. Powell & Leland, and Smith & Beck; the very slight allusion to the "American contrivance" being a disparaging one, and stating an untruth. How far Messrs. Powell & Leland and Smith & Beck are responsible for this does not yet appear. In justice I must except the notice in the Chemical News which is more candid. It is painful to be obliged to make these remarks, and most sincerely it is to be hoped that no further occasion will be given for complaint. England can well afford to be generous.

3. *New Eruption of Mauna Loa;* by Rev. Titus Coan. (Editorial correspondence, dated Hilo, Feb. 27, 1866.)—Another eruption has recently commenced on Mauna Loa. The light was first seen on the night of the 30th Dec., 1865, at the very summit of the mountain. From that day to the present the eruption has continued with varying intensity. Sometimes the light is quite brilliant, shedding a glow over all the higher portions of the mountain, sending down its reflection upon our

town and landscape, and throwing its ruddy sheen upon the clouds. In the day time the smoke goes up like the smoke of a great furnace.

It is not, however, at all times equally active, and occasionally we imagine that it has become extinct. But we are soon undeceived by new manifestations, sometimes appearing as if the molten lavas were being ejected high in the air.

As yet there has been no lateral outbreak and no longitudinal flow. The eruption is evidently in the vast summit crater Mokuaweoweo, where Wilkes encamped, and the action has been confined to this point.

We have looked for an overflow, or for a cleft in the walls of the crater for the discharge of the lavas, but none may occur. The crater is so deep and ample that the active forces of the eruption will, probably, be expended in the abyss where the fires are now raging.

During this summit eruption we have noticed Kilauea with great interest, and have had numerous reports from there. We do not get evidence of any sympathy between the two craters. Old Pele is, as usual, with no apparent increase or diminution in her activity.

We have had much thunder and lightning this winter, with tempestuous winds, hail and snow. The falls of snow upon the mountains have been frequent and heavy, extending almost to their bases.

3. *American Association for the Advancement of Science.*—We observe, with pleasure, that measures are in progress to revive this Association after a suspension of its operations for nearly six years. An invitation has been tendered to the Association, by the citizens of Buffalo, to make that city the place of holding the first meeting after the revival; and this invitation has been accepted in behalf of the Association by its President, Dr. F. A. P. Barnard, of Columbia College, with the sanction of the Standing Committee. According to present expectation, the meeting will take place about the middle of August; but should the threatened epidemic become seriously prevalent in the country, a later date will be fixed on. When the time shall have been positively determined, circular notices will be issued to the members, by the permanent Secretary, Prof. Lovering, of Harvard University.

The Association, previous to the discontinuance of its annual meetings, proved itself a useful means of promoting a spirit of scientific inquiry in the country, and awakening a popular interest in scientific progress. The suspension of its operations, a misfortune in itself, was one of the consequences of the greater misfortune in which the whole country became involved by the attempt, now at length happily baffled, to overthrow the government. We anticipate both pleasure and profit to the votaries of science in the country from the renewal of those periodic reunions, which always brought with them a social interest superior perhaps to the scientific; and we cannot but hope that the Association may prove to some extent instrumental in healing the wounds created by civil war.

4. *On Magnesia in hydraulic cements;* by H. St.Claire Deville.—At the session of the Paris Academy of the 4th of December last, Deville showed that magnesia, kept for some weeks in pure water sealed up so that the air is excluded, combines with water, and forms a hard and compact crystalline translucent substance, consisting of magnesia 68·3,

water 31·7, or a simple *hydrate of magnesia*. He has made copies of medals, like those of plaster, from magnesia thus hardened under water. Balard's magnesia, calcined at a red heat, he says, has hydraulic qualities which are manifested with a rapidity that is most admirable; though when calcined at a white heat, the property is almost wholly lost. A mixture of pulverized chalk or marble and magnesia in equal parts furnishes with water a paste which is a little plastic, but which after being some time in water affords products "of extreme solidity," and he purposes to use the mixture for making busts of artificial marble. Plaster mixed with magnesia diminishes the hydraulic properties.

On calcining dolomites rich in magnesia at a low temperature, below red heat, the powder solidifies under water very rapidly, and gives a stone of a hardness which is "really extraordinary." If calcined at a somewhat higher temperature so that a little lime is produced in the mass, the hardening still takes place, but the lime forms veins of pure aragonite in the mass, free from magnesia, the fibers of which are seen to be distinct hexagonal prisms under the microscope. When the dolomite is heated to redness, and all the lime is reduced to the state of quicklime the hydraulicity is lost. In the above results, the magnesia is the hydraulizing ingredient, it soldering together the particles of carbonate of lime exactly as in the mixture of magnesia and marble dust.

The magnesian materials obtained by Deville have been exposed for a long time to the action of sea water in the port of Boulogne by Mr. P. Michelot, and have stood perfectly the trial. Deville observes that the results explain the successful trials of Mr. Vicat from mixing magnesia with marine cements. They lead him to hope that we may thus find extensive use for a substance which, through the admirable processes of Mr. Balard, is now furnished at a very low price, and in indefinite quantities.—*Les Mondes*, Dec. 7, 1865.

5. *Meteorites of Aumale, Algeria.*—A fall of meteorites took place on the 25th of August last between 11 and 12 M., in Algiers, in the district of Aumale, and 50 kilometers north of that village. The mass taken to Algiers weighed 6·8 kil., but the whole meteorite is estimated at beyond 25 kil.

On the same day and hour, a second meteorite fell in the region of the tribe of Senhadja, "fraction des Beni-Ouelben," 4800 meters N. 12° E. from the place of fall of the former, in 0° 20′ E. and 36° 27′ N. This second specimen was about as large as the first, and was like it also in having approximately the form of a parallelipiped.

The meteorites consist mostly of a fine-grained ash-gray stony substance, scratching glass easily. In this base small metallic grains are disseminated, part composed of nickeliferous iron; numerous of a yellow bronze color, acting like monosulphuret of iron; some of brass-yellow possessing the characters of ordinary pyrites; black grains of chromiron in regular octahedrons with truncated edges. The specific gravity of the meteorite is 3·65. One marked peculiarity is the presence of salts soluble in water, consisting of chlorid of sodium with some carbonate of soda. The thin crust of the meteorite is dull black, slightly rugose. Within the mass there are planes, nearly flat, which are striated evidently by the friction of the two surfaces.—*Ib.*, Feb. 15.

6. *Large mass of meteoric iron.*—A mass weighing 8287½ lbs. (3,750 kil.) was received last year at the British Museum from Australia.—*Ib.*, Aug. 10.

7. *Remains of the Post-tertiary Mastodon or Elephant in Montana.*—The "Montana Radiator" states that a large molar tooth and a tusk of an elephantine animal have recently been found in the "claim of Dr. Fales" in Last-Chance Gulch opposite the end of Broad street, seventeen feet below the surface, and four feet from the rock beneath. The tusk is 15 feet long, and 4 feet from the smaller extremity it is 27½ inches in circumference; it was found 25 feet farther up the gulch than the tooth.

8. *Artificial Ivory.*—The best imitation of ivory—a kind now much used—is made by dissolving either caoutchouc or gutta-percha in chloroform, passing chlorine into the solution until it has acquired a slightly yellow tint, washing it well with alcohol, then adding, in fine powder, sulphate of baryta, sulphate of lime, sulphate of lead, alumina or chalk, in quantities proportioned to the density and tint desired; then hardening it, and finally subjecting it to heavy pressure. An ivory-like substance is thus made which is of great hardness and will receive a high polish.—*Les Mondes*, Nov. 9, 1865.

9. *Solution of Silk.*—A solution of silk may be made by boiling it with a concentrated solution of chlorid of zinc over an excess of oxyd of the same metal, until it no longer discolors the tincture of litmus. By dialysis, the silk may be obtained again in a colorless inodorous form.—*Ib.*, Jan. 4.

10. *New artificial light for photography.*—Mr. Sayers, of Paris, obtains a light almost equal in power to that of magnesium, and much cheaper, from the combustion of a mixture of 24 parts of well-dried and powdered nitrate of potash with 7 of flowers of sulphur and 6 of red sulphuret of arsenic. The mixture costs only 12 cents a kilogram.—*Ib.*, Jan. 4.

11. *New test for distinguishing Cane sugar from the sugar of Grapes.*—H. Leplay observes that the sugar of grapes blackens bichlorid of carbon, while cane sugar does not.—*Ib.*, Dec. 14, 1865.

12. *Petroleum in Archangel.*—A source of petroleum has been found in Russia, in the government of Archangel, near a streamlet which runs into the river Betchora. The oil taken from it can be conveniently brought to the interior of the empire by the ordinary routes to Kama, and from there to the different regions along the Volga.—*Ib.*, Dec. 7, 1865.

13. *Petroleum of Zante.*—A company has been formed for working the abundant sources of petroleum in Zante, one of the Ionian islands, sources which have been flowing, at least, for 2000 years, and which are well described by Herodotus.—*Ib.*, Oct. 2, 1865.

14. *Discovery of Stone-implements on the Island of Elba by Mr. Foresi.*—Nine-tenths of the ancient implements found by Mr. Foresi on Elba are made of kinds of stone not occurring on the island, some consisting of obsidian from Naples, and others of material which has come from a greater distance. It is a question, therefore, whether they were introduced by invaders, or by commerce.—*Ib.*, Oct. 19, 1865.

15. *Polar expedition of Prussia and Austria.*—This expedition leaves this spring, will first go to Spitzbergen, and make Hammerfest, the bay of which never freezes, its base of operations. On Spitzbergen it proposes to explore the coal beds noticed there more than a century since by the Dutch. It will next explore Giles land, and then pass on westwardly as far as possible toward the pole, to resolve the question of the open sea; and reaching Greenland, will explore the coast, going north

ward. Finally the expedition will turn eastward, cross in all directions the sea of Siberia, and if chances are favorable, will return by the polar seas of America. The time allotted for the expedition is eight months.

16. *Geological Survey of California.*—The Legislature of California has recently made an appropriation of 45,000 dollars for the continuation of the geological survey so well begun and carried forward by Prof. Whitney.

17. *Copley Medal.*—The Copley medal for 1865 has been given to the eminent French mathematician, Mr. Chasles.

OBITUARY.

Dr. WHEWELL died on Tuesday, March 10, at twenty minutes past five P. M., at the Lodge, Trinity College. He was born at Lancaster in 1795. His parentage was humble, and it is said that his father intended to devote him to his own handicraft, but he was sent to the free Grammar School of Lancaster, and proceeded in due course to Trinity College. His position in the Mathematical Tripos as Second Wrangler, followed by the acquisition of the Second Smith's Prize, proved the possession of the intellectual powers which he cultivated up to the day when he suffered the accident which has since proved fatal. In due time he became Fellow and Tutor in his college. In 1828 he was elected Professor of Mineralogy, succeeding Dr. Clarke. It was in connection with the British Association (of which he was President in 1841) that he drew up the "Reports on the Tides," and on the "Mathematical theories of Heat, Magnetism, and Electricity," which rank among the first of his mathematical productions. Before this he was chosen to write the "Bridgewater Treatise on Astronomy," which perhaps suggested to him the "History of the Inductive Sciences," published in 1837, followed in 1840 by the "Philosophy of the Inductive Sciences," which are undoubtedly the works by which he will be best known in after years. In 1832 he resigned the Professorship of Mineralogy, but in 1838 accepted the Professorship of Moral Philosophy, which he held till 1855. In 1841, during the Ministry of Sir Robert Peel, he was nominated to the Mastership of Trinity, on the resignation of Dr. Wordsworth. As professor of Moral Philosophy he founded prizes for the encouragement of that study, which he himself always pursued with avidity. He edited Sir James Mackintosh's "Introduction to the study of Ethical Philosophy," published a couple of volumes of his own on "Morality," and among his latest productions were some translations of the "Ethical Dialogues of Plato." Besides University text-books, he published "Lectures on Political Economy," an edition of the works of Richard Jones on "Political Economy," "Architectural Notes on Churches in France and Germany," and "Some Specimens of English Hexameters," published in a book containing similar efforts by Sir John Herschel, the late Archdeacon Hare, and Mr. Lockhart.—*Reader, March* 10.

Mr. WILLIAM THOMAS BRANDE, D.C.L., F.R.S., the well-known chemist of the Royal Mint, died at Tunbridge Wells on Sunday, February 18th, aged eighty, being born in 1786. In 1803 he communicated several papers to Nicholson's Journal, one on guaiacum, which was read before the Royal Society. In 1808 he lectured on chemistry at Dr. Hooper's in Cork Street. Then he was connected with the Medical School in Wind-

mill Street, and served as a teacher and demonstrator of chemistry. In 1809 he became F.R.S., received the Copley Medal in 1813, and from 1813 to 1826 was Dr. Wollaston's successor as senior secretary to the society. In 1812 he became a Professor of Chemistry and Materia Medica to the Apothecary's Company, and in 1851 was elected Master. In 1813, on Sir H. Davy's recommendation, he was appointed Professor of Chemistry at the Royal Institution, and delivered lectures for many years in conjunction with Mr. Faraday, and was also associated with him as editor of the Quarterly Journal of Science. In 1825 he was appointed superintendent of the Die Department of the Mint; in 1836 Fellow, and in 1846 Examiner, of the London University. Besides the "Manual of Chemistry," he was author of "Outlines of Geology," "Dictionary of Science and Art," &c.—*Reader, Feb.* 24.

Dr. Wm. M. Uhler.—Dr. Uhler, a chemist of some note, and an excellent friend of science, died at Philadelphia on the 27th of November last.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Carte Agronomique des Environs de Paris,* dressée, avec l'autorisation du Ministre de la Guerre, sur la carte topographique de L'Etat-Major, publié conformément a une déliberation de la Commission Départementale, et exécutée d'après les ordres de M. le baron G. E. Haussmann, Sénateur, Préfet de la Seine, par M. Delesse, Ingénieur des Mines du Départment de la Seine. Paris. (J. Dumaine.)—This map, as its title indicates, is designed to show the agricultural features of the region about Paris, embracing a territory of about 556 square miles (English). It is very complete in its details, and exhibits at a glance the most characteristic features of the soil, as well as the topography of the country. The primary division into soils that are calcareous, and those that are not, and again into those rich in humus, and those poor in that substance, are indicated by colors, as on an ordinary geological map. The topography, roads, forests, pastures, gardens, and vineyards are shown in the printing by well known methods. By an ingenious system of lines, dots, or characters, arranged according to certain orders, and printed in colors, the minuter characters of the soil are shown, such as the comparative prevalence of sand, loam, clay, gravel, siliceous or calcareous stones, and carbonic acid; and moreover by letters and figures also in colors, the per-centages of these several ingredients are successfully shown. The map has not only the merit of great ingenuity, but possesses a high value to the agriculturist, and is a text-book in itself. It is executed on a scale of $\frac{1}{40000}$, (about $1\frac{1}{2}$ inches to the mile,) and the mechanical execution is in the best style of the art. It is a most valuable addition to agricultural science, and embodies the results of an immense amount of labor. W. H. B.

2. *Sveriges geologiska Undersökning—Swedish Geological Survey,* under the direction of Professor Axel Erdmann.—The publication of the Geological Chart of Sweden, begun by Royal orders in 1861, has already made much progress. The work is projected on a scale as to magnitude, geological detail and artistic work, that is truly regal. The surface of Sweden is divided into 20 areas, and these areas are quartered; and, for each of the parts thus made, 77 in all, a map is issued measuring

18 by 24 inches in surface, so that the whole chart will cover an area of 231 square feet. The scale is $\frac{1}{50,000}$. The number of maps which had appeared up to November, 1865, is 18. The maps show in every part that they are the result of minute and careful exploration, by able and thorough geologists. Even the outlines of the older and newer Drift, and of the more recent Alluvium, are indicated by colors. Each chart is accompanied by a pamphlet, in 8vo, of 30 to 75 pages, giving details respecting the region represented, with numerous sections, and bearing upon the title page the name of the assistant in the survey who had special charge of that portion of the work. The names on the eighteen parts received by us are V. Karlsson, E. Sidenbladh, O. F. Kugelberg, A. E. Törnebohm, J. O. Fries, A. H. Wahlqvist, C. W. Paijkull, E. Erdmann, D. Hummel, and O. Gumælius.

The price for each chart with the text pertaining to it is two Swedish dollars. An accompanying notice states that they may be procured of the "Bureau de la Recherche Géologique de la Suède," by addressing Mr. Adolf Bonnier, Stockholm, through C. Reinwald, Paris, Longman & Co., London, or K. F. Köhler, Leipsic.

3. *Die Steinkohlen Deutschland's und anderer Länder Europa's;* by Dr. H. B. Geinitz, Dr. H. Fleck and Dr. E. Hartig, Professors in the K. polytechn. School in Dresden.—The second volume of this great work on the Mineral Coal of Germany and the rest of Europe, the first of which is noticed in our number for March, has just reached us. It is a quarto volume of 424 pages. Its subjects are The History, Statistics, and applications to the arts, of Mineral Coal. Each is treated with all needed fulness and detail. The last includes chapters on the physical peculiarities and chemical composition of the coals of different regions. The work is illustrated with drawings of machines, apparatus, furnaces, and maps, all handsomely executed, and well adapted to make the work practically useful to the miner and political economist.

4. *Annual of the National Academy of Sciences for* 1865. 130 pp., 12mo. Cambridge, 1866.—Besides the constitution and bylaws, lists of members, and lists of papers presented at the meetings of the year, this Report contains an excellent biographical sketch by Major J. G. Barnard of the eminent engineer General Joseph Gilbert Totten, who died on the 22d of April, 1864.

5. *Report of the Commissioner of Agriculture for the year* 1864. 676 pp., 8vo, with numerous woodcuts. Washington, 1865.—This annual Report treats, among its various articles, of Sorghum, by Wm. Clough; the Game Birds of the U. States, by D. G. Elliot; Oology of New England Birds, by E. A. Samuels; Noxious Insects, by T. Glover; and of many subjects especially interesting in connection with agriculture, horticulture, wool-growing, care of stock, etc.

6. *Reise der osterreichischen Fregatte Novara um die Erde in den Jahren* 1857, 1858, 1859, unter den Befehlen des Commodore B. von Wullerstorf Urbair. *Nautisch-physicalischer Theil.* III (letzte) Abtheilung. 135–490 pp., 4to. With maps. Vienna, 1865. (Carl Gerold's Sohn.)—This part concludes the Nautico-physical Report by Dr. Scherzer of the Austrian Expedition of the frigate Novara around the world. It is occupied with the tables of the meteorological observations, which appear to have been made with great thoroughness and care. They are

accompanied with maps showing the route, and a large chart of the Nicobar Islands.

Three zoological volumes with plates were also issued in 1865, (1) on *Birds*, by Mr. de Palzeln; (2) on *Crustacea*, by Dr. Heller; (3) on *Formicidæ*, by Dr. G. Mayer.

7. *Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College.* No. II. North American Acalephæ; by ALEXANDER AGASSIZ. 234 pp. royal 8vo, with numerous illustrations. Published by order of the Legislature of Massachusetts. Cambridge, 1865. (Sever & Francis.)—A notice of this very beautiful and excellent work is unvoidably deferred to another number.

Various Memoirs on Species of Mollusca, by ISAAC LEA, LL.D. 32 pp., 8vo. From the Proceedings of the Academy of Natural Sciences at Philadelphia, Feb. 1863 to May 1865.—They treat of, Leaia Leidyi; 14 n. sp. of Melanidæ; 11 n. sp. of exotic Unionidæ; 24 n. sp. of Unionidæ; a new Unio and a Monocondylœa; a new genus of Melanidæ; 11 n. sp. of Melanidæ; Planorbis Newberryi; 6 n. sp. of Unionidæ from Lake Nyassa; 6 n. sp. of Succinea, etc.; 13 n. sp. of Melanidæ; n. sp. of Planorbis; 5 n. sp. of Lymnea; 2 n. sp. of Unionidæ from S. Africa; 24 n. sp. of Physa; 6 n. sp. of W. African Unionidæ; 3 n. sp. of exotic Uniones; 8 n. sp. of Unio.

The Living Forces of the Universe, the Temple and the Worshippers, by Hon. GEO. W. THOMPSON, of Wheeling, West Virginia. 388 pp. 12mo. Philadelphia, 1866. (Howard Challen.)—The author of this work goes into the region of mysteries farther than we can follow him.

Historical notice of the Essex Institute. 44 pp. 8vo. Salem, 1866.

Zoologie, contenant l'Anatomie, la Physiologie, la Classification, et l'Histoire naturelle des Animaux, by PAUL GERVAIS. 448 pp. 8vo, with a large number of woodcuts. Paris. (Hachette.)

Traité pratique d'Analyse Chimique, by F. WOEHLER.—French translation by Grandeau and Troost. 324 pp. in 18mo. Paris. (Gauthier-Villars.)

Les grandes Usines de France: Etudes industrielles en France et à l'étranger; by TURGAN. In small 4to. Paris. (Michel Lévy.)

L'Espace Celeste et la Nature Tropicale; Descriptions physique de l'Univers, d'après des Observations personelles faites dans les deux hémisphères, by EMANUEL LIAIS.

PROCEEDINGS BOSTON SOC. NAT. HIST., Vol. X.—Page 49, Relations of the soil to subjacent rocks; *Niles.*—p. 51, Habit of the earth-worm; *Wyman.*—p. 64, Resemblance of fishes of Milwaukee river to those of Lake Superior and L. Champlain; *Putnam.*—p. 66, Habits of some American fishes; *N. E. Atwood.*—p. 69, On two human skulls from Stockton, Cal.; *J. C. White.*—p. 72, Iron ore of Staten Island, and on preparing Peat; *C. T. Jackson.*—p. 75, Fossils from Riobamba; *Winslow.*—p. 79, Facts connected with the development of frogs; *C. E. Hamlin.*—p. 80, Habit of Certhia Americana; *C. E. Hamlin.*—p. 81, Habits of some Sharks; *Atwood.*—p. 84, Emery in Chester, Mass.; *C. T. Jackson.*—p. 90, On the type of Buteo insignatus *Cassin; H. Bryant.*—p. 91, On Sphyropicus varius *Linn.; H. Bryant.*—p. 93, Anatase in R. Island; *E. B. Eddy.*—p. 94, On the anatomy and physiology of accommodation in the human eyes; *Wyman.*—p. 96, On Miamia and Hemeristia; *Scudder.*—p. 101, Note on Rhabdonema magnificum; *C. Stodder.*—p. 103, Habits of the Cod; *Atwood.*—p. 105, On the fossil bones of Riobamba; *Wyman.*—p. 107, New species of Nitzschia; *R. C. Greenleaf.*—pp. 109–160, etc., Report of Annual Meeting, held May 3, 1865.

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